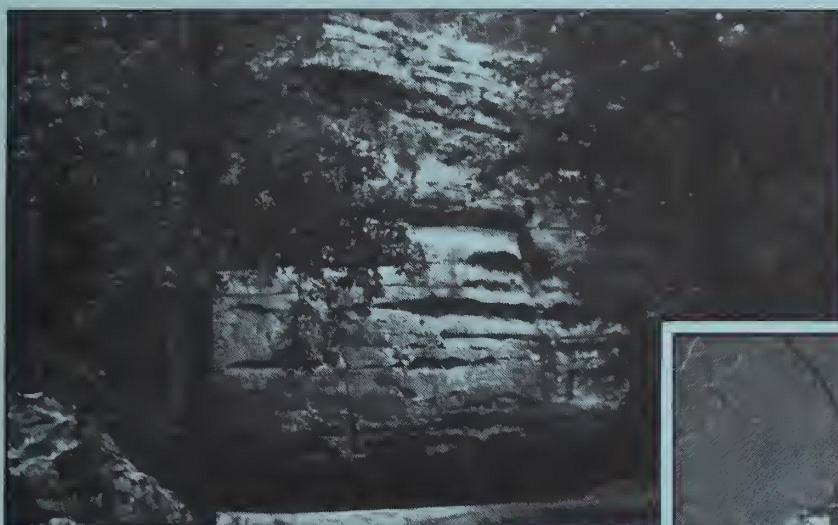
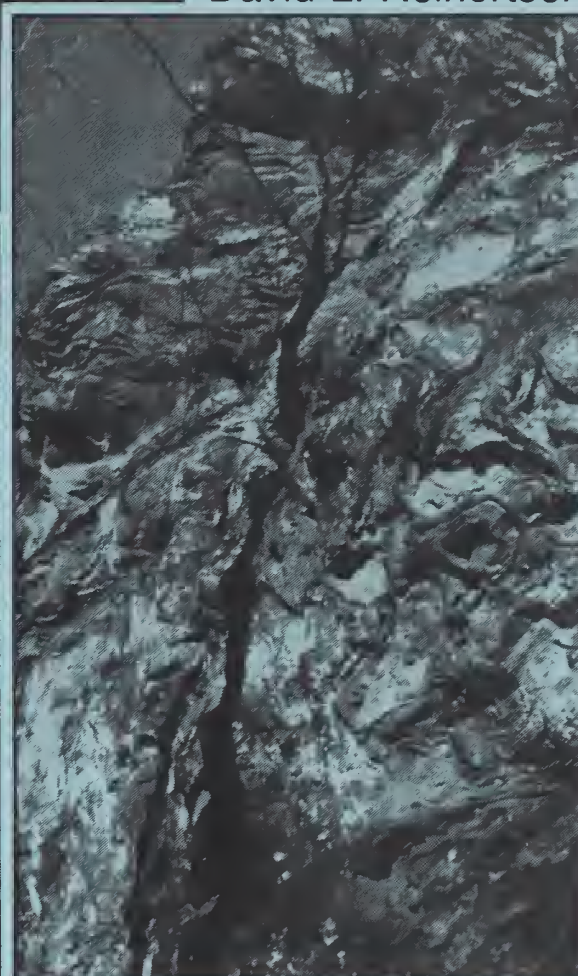
Guide to the Geology of the Ferne Clyffe Area, Johnson, Pope, Saline, and Union Counties



Joseph A. Devera
Stephen T. Whitaker
David L. Reinertsen



Geological Science Field Trip 1990A, April 21, 1990
Department of Energy and Natural Resources
ILLINOIS STATE GEOLOGICAL SURVEY
Champaign, Illinois 61820

GEOLOGICAL SCIENCE FIELD TRIPS are free tours conducted by the Educational Extension Unit of the Illinois State Geological Survey to acquaint the public with the geology and mineral resources of Illinois. Each is an all-day excursion through one or several counties in Illinois. Frequent stops are made to explore, explain, and collect rocks and fossils. People of all ages and interests are welcome. The trips are especially helpful to teachers in preparing earth science units. Grade school students are welcome, but each must be accompanied by a parent or guardian. High school science classes should be supervised by at least one adult for each ten students. A list of earlier field trip guide leaflets for planning class tours and private outings may be obtained by contacting the Illinois State Geological Survey, Natural Resources Building, 615 East Peabody Drive, Champaign, Illinois 61820. Phone (217) 244-2407 or 333-7372.

Printed by authority of the State of Illinois/1990/500

Guide to the Geology of the Ferne Clyffe Area, Johnson, Pope, Saline, and Union Counties

Joseph A. Devera
Stephen T. Whitaker
David L. Reinertsen

Geological Science Field Trip 1990A, April 21, 1990
Department of Energy and Natural Resources
ILLINOIS STATE GEOLOGICAL SURVEY
Champaign, Illinois 61820

CONTENTS

FIGURES

GEOLOGIC FRAMEWORK OF THE FERNE CLYFFE AREA

Diverse topography, relief, structure, geological history, and distinct biota characterize the Ferne Clyffe field trip area in Johnson, Pope, Saline, and Union Counties in southern Illinois. Our route takes us through the scenic grandeur of the Shawnee Hills ("Illinois Ozarks"), which lie about 310 miles south-southwest of Chicago, 160 miles south-southeast of Springfield, and 37 miles north-northeast of Cairo. About 10 miles south of the northern boundary of the Shawnee Hills is Ferne Clyffe State Park, where we will begin the trip.

Bedrock The geology of the Ferne Clyffe field trip area has changed many times through hundreds of millions of years. The ancient Precambrian basement, composed of igneous granitic and possibly metamorphic crystalline rocks more than 1 billion years old, was deeply eroded when it was exposed at the Earth's surface more than 500 million years ago. This erosion formed a landscape similar to that seen today in parts of the Missouri Ozarks.

A gradual subsidence of the region began to dominate other geologic factors, such as erosion and stream downcutting, about 520 million years ago and resulted in invasion of a shallow sea from the south and southwest. During the next 250 million years (a period that geologists call the Paleozoic Era), the area that is now southern Illinois was subjected to repeated advances and withdrawals of the sea. When the seas advanced, sediments were deposited; and when the seas withdrew, sediments were weathered and eroded. As a result, the sedimentary record shows some gaps. By the end of the Paleozoic Era about 250 million years ago, at least 15,000 feet of sedimentary strata had accumulated (figs. 1 and 2) in parts of Illinois. These strata range from about 523 million years old, the Cambrian Period of the Paleozoic Era, to 288 million years old, the Pennsylvanian Period.

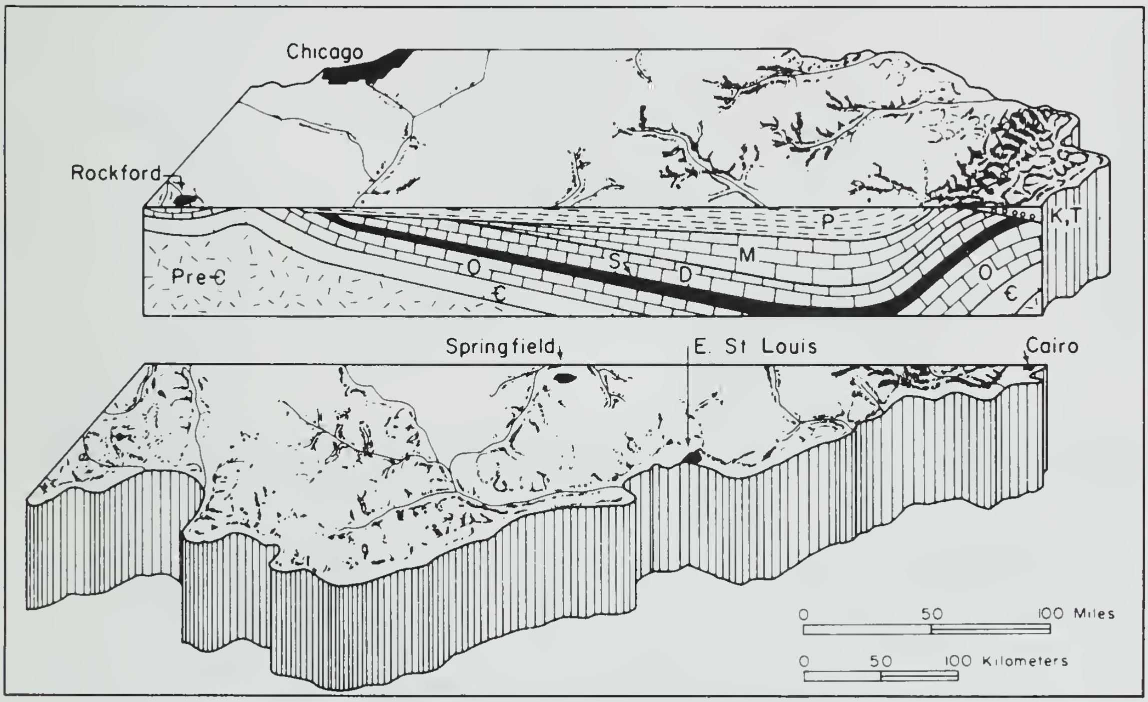


Figure 1 Stylized north-south cross section shows structure of the Illinois Basin. To show detail, the thickness of the sedimentary rocks is greatly exaggerated and the younger, unconsolidated surface deposits have been eliminated. The oldest rocks, Precambrian (Pre-Є) granites, form a depression filled with layers of sedimentary rocks of various ages: Cambrian (C), Ordovician (O), Silurian (S), Devonian (D), Mississippian (M), Pennsylvanian (P), Cretaceous (K), and Tertiary (T). The scale is approximate.

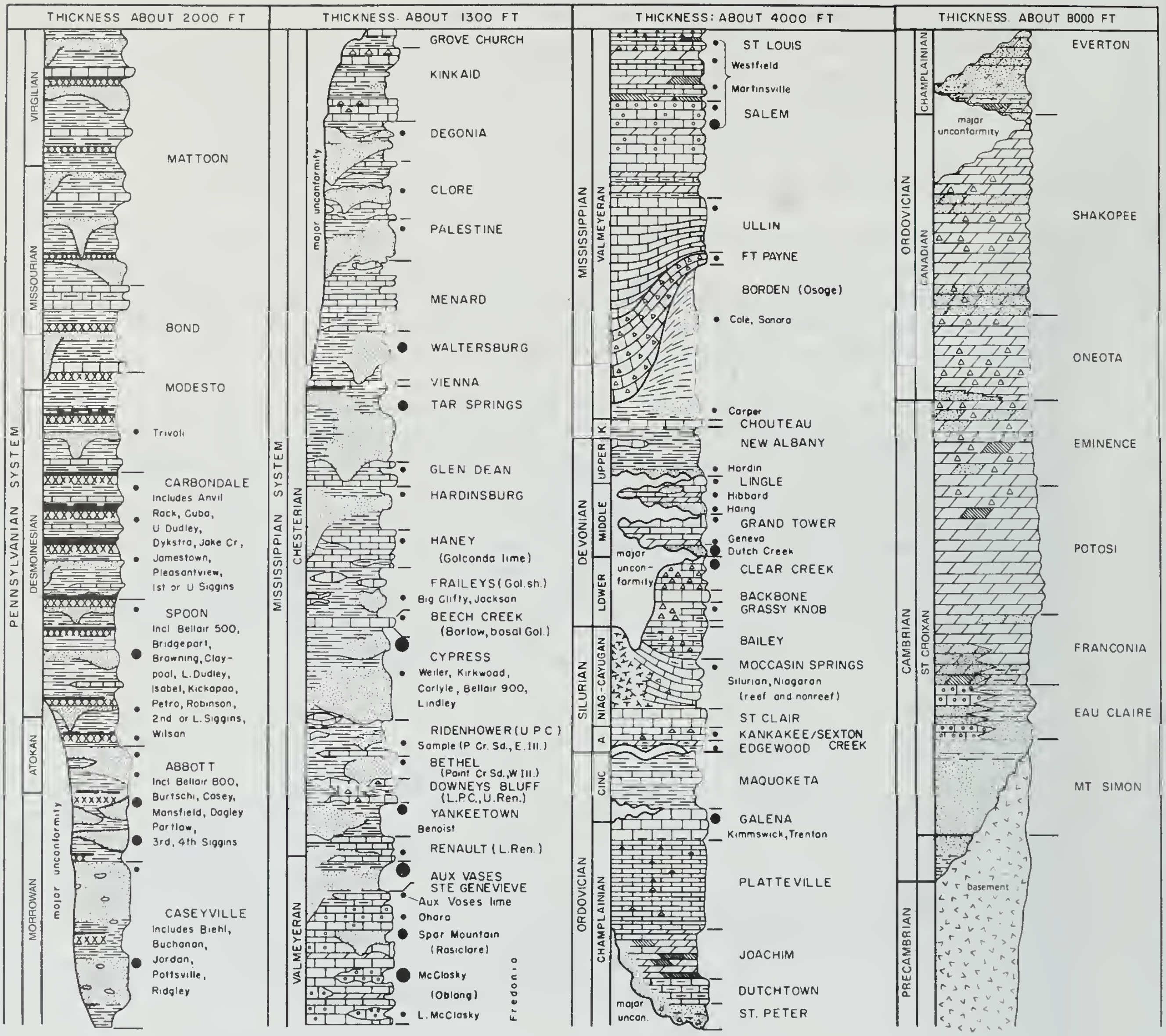


Figure 2 Generalized geologic column of southern Illinois. Black dots indicate oil and gas pay zones. Formation names are in captitals; other pay zones are not. About 4,000 feet of lower Ordovician and upper Cambrian rocks under the St. Peter are not shown. (Originally prepared by David H. Swann.)

Evidence from outcrops and drill holes elsewhere in Illinois and adjacent states indicates that younger rocks of latest Pennsylvanian and Permian (the youngest Paleozoic rocks) or perhaps even younger age may have been deposited in this area. However, during the 245 million years between the close of the Paleozoic Era and the onslaught of glaciation 1 to 2 million years ago, ample time passed for the erosion of any post-Pennsylvanian rocks that may have been present. In fact, indirect evidence based on the rank of coal deposits and the generation of petroleum from source rocks indicates that erosion has removed as much as 1 1/2 miles of younger rocks once covering southern Illinois. In the field trip area, Paleozoic sedimentary strata reach thicknesses of more than 11,000 feet in the southwest and some 12,500 feet in the north.

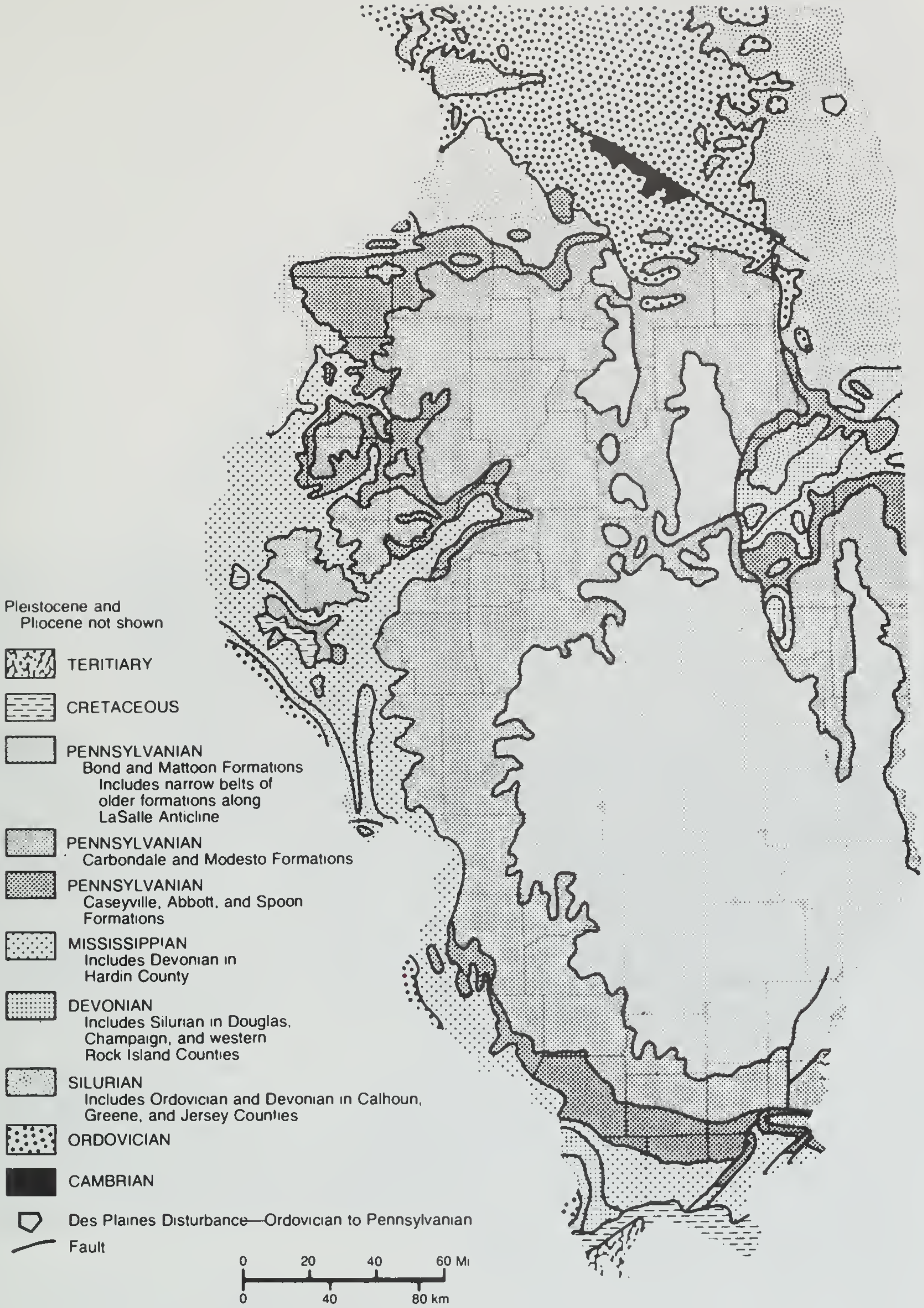


Figure 3 Geologic map of Illinois.

The oldest bedrock strata that are exposed in the field trip area are late Mississippian (Chesterian) and occur in the southern part. These rocks are principally limestones, shales, and siltstones formed from limey, muddy, and silty sediments deposited across ancient shallow sea bottoms nearly 325 million years ago. Figure 3 shows the areal distribution of the Mississippian and Pennsylvanian rocks in Illinois.

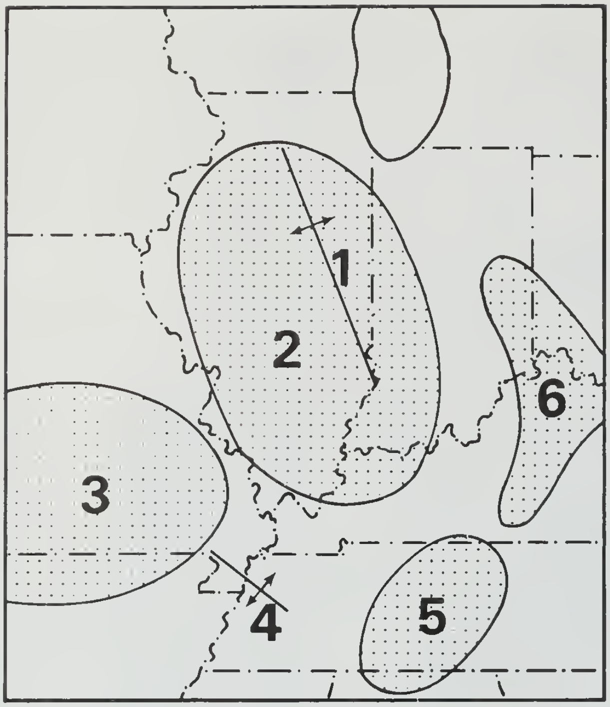


Figure 4 Location of some major structures in the Illinois region: (1) LaSalle Anticlinal Belt, (2) Illinois Basin, (3) Ozark Dome, (4) Pascola Arch, (5) Nashville Dome, and (6) Cincinnati Arch.

Pennsylvanian bedrock strata of sandstone, siltstone, shale, limestone, coal, and underclay lie immediately beneath a thin cover of soil. They were deposited as sediments in shallow seas and swamps between about 320 and 307 million years ago. Many of these rocks are exposed in road and stream cuts, as well as along hillsides. From the steep, south-facing exposures along the east-west trending Pennsylvanian escarpment across the middle of the field trip area, the thickness of Pennsylvanian strata increases north and eastward from an eroded edge to more than 600 feet in northwestern Pope and south- western Saline Counties. A description of these rocks and how they formed may be found at the back of this guide leaflet in *Depositional History of the Pennsylvanian Rocks*. (A glossary defining italicized words in the text can also be found near the back of the guide leaflet.)

Structural and Depositional History After the Paleozoic Era and during the Mesozoic Era (about 240 to 63 million years ago), the rise of the Pascola Arch in southeastern Missouri and western Tennessee separated the Illinois Basin, for the first time, from other basins to the south. Development of the Pascola Arch following subsidence of the deeper parts of the Illinois Basin produced the asymmetrical, spoon-shape depression that now covers much of Illinois, southern Indiana, and western Kentucky (fig. 4). The Ferne Clyffe field trip area lies along the southwestern rim of the Illinois Basin.

Glacial History Continental glaciers—massive sheets of ice thousands of feet thick—began to flow slowly southward from Canada about 1.6 million years ago during the Pleistocene Epoch (about 2 million years to about 10,000 years ago). The last of these glaciers melted from northeastern Illinois about 13,500 years before the present (B.P.) near the close of Wisconsinan time. Although ice sheets covered Illinois several times during the Pleistocene Epoch, North American continental glaciers reached their southernmost extent during the Illinoian glaciation around 270,000 years B.P. They advanced from centers of snow and ice accumulation in Canada as far south as northern Johnson County, about 4 miles northeast of here (fig. 5). The glacier came within about 2 miles of reaching the ridge crest of the gentle north slope of the Pennsylvanian escarpment.

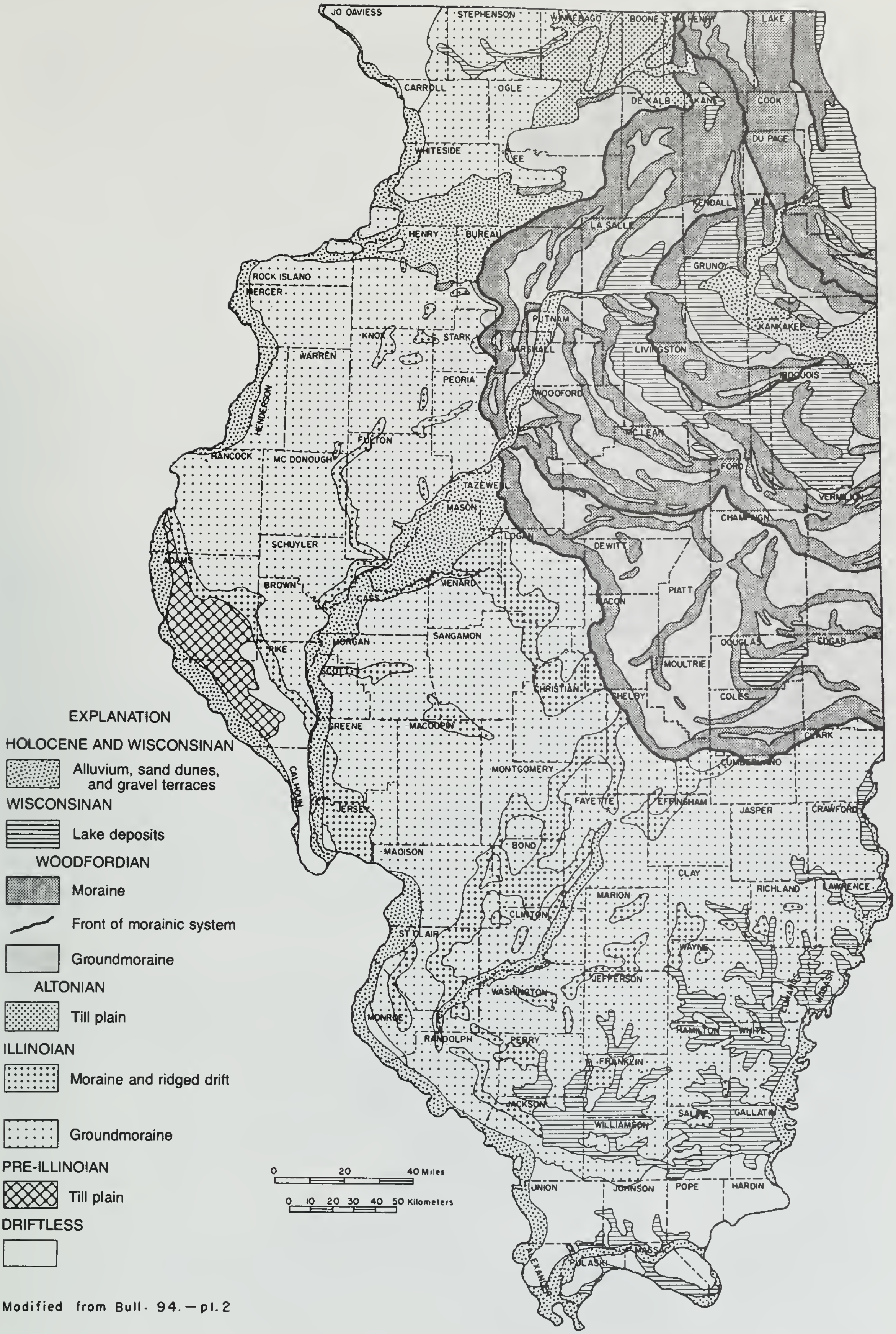


Figure 5 Generalized map of glacial deposits in Illinois (modified from Willman and Frye 1970).

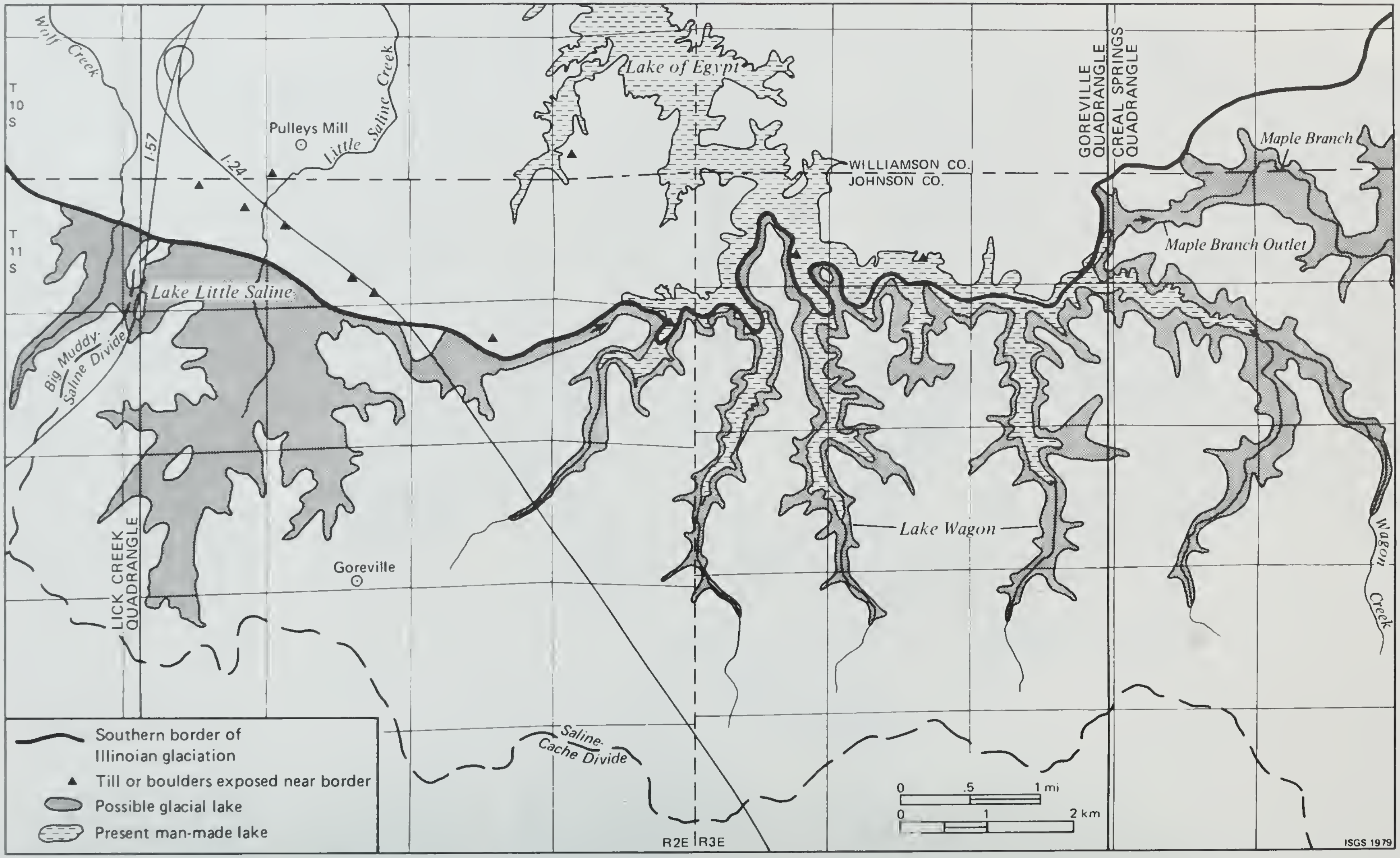


Figure 6 Glacial boundary and ice-front lakes in Ferne Clyffe area (from Willman and Frye 1980).

Although Illinoian glaciers probably built morainic ridges similar to those of the later Wisconsinan glaciers in northeastern Illinois, the earlier moraines apparently were not so numerous and have been exposed to weathering and erosion for thousands of years longer than their younger counterparts. No prominent morainal ridge crosses southern Illinois. Thus the ice front apparently did not stand across the area long enough to deposit a distinct moraine, even though the ice may have been several hundred feet thick. The absence of an end moraine has been interpreted as an indication that the Illinoian ice sheet stagnated. Because there was no forward movement of the glacier, little or no rock debris was carried to the ice margin where it could be deposited to form a moraine.

Melting ice formed lakes that extended southward from the ice margin into the valleys of north-flowing streams (fig. 6). The surface elevation was not identical in all of these lakes. Just to the west of the field trip area, the water level became high enough in several places to briefly overflow southward through low sags in the Pennsylvanian escarpment. In the Ferne Clyffe area, it appears that drainage from the eastern meltwater lakes either drained eastward across the front of the ice margin or beneath the ice via a series of subglacial channels into what is now the Saline River drainage system. The field trip route crosses an arm of one of the lakes just west of Goreville.

The topography of the bedrock surface throughout much of Illinois is largely hidden from view by glacial deposits except along the major streams. In many areas, the glacial drift is thick enough to completely mask the underlying bedrock surface. The field trip area was not covered either by glacial ice or drift deposits, however, so the preglacial bedrock surface has been only slightly modified and subdued by a thin mantle of soil.

Although southern Illinois was not glaciated during Wisconsinan time from about 75,000 to 10,000 years B.P. thick deposits of sand and gravel called valley trains were laid down along the Mississippi River. During the severe winters, as meltwater streams diminished, the valley trains dried out. The harsh, bitter, northwest winds swirled across these deposits winnowing out and carrying the fine sand, silt, and clay eastward to deposit them across the upland. These eolian (windblown) deposits called loess (pronounced "luss"), were laid down adjacent to the major rivers where deposits tens of feet thick occur closeby; thickness diminishes rapidly toward the east. Loess deposits in the Ferne Clyffe field trip area decrease in thickness from the southwest to the northeast, from approximately 13 to 5.5 feet. The loess deposits are the parent materials from which the modern soils developed in this area.

Physiography Physiography is the study and classification of the surface features of the Earth based on similarities in geologic structure and history of geologic changes. The physiographic contrasts between various parts of Illinois are due to a number of factors and conditions, such as, bedrock surface topography, extent of the various glaciations, differences in glacial topography, differences in age of the uppermost glacial drift, effects of erosion on the surface, etc. The Ferne Clyffe field trip area is situated in the central part of the western Shawnee Hills Section, the westernmost division of the Interior Low Plateaus Province (fig. 7). The Shawnee Hills Section has been called the "Illinois Ozarks" because of its rugged, scenic terrain.

The Shawnee Hills sits along the southern rim of the Illinois Basin so that the lower Pennsylvanian *cuesta* (pronounced "kwesta") underlies the northern part of the section and a dissected plateau underlain by upper Mississippian strata comprises the southern part. The Pennsylvanian cuesta (escarpment) forms a continuous ridge and drainage divide across southern Illinois from the Mississippi River eastward to the Ohio River. Generally the cuesta is maturely dissected by youthful valleys—that is, some remnant uplands still separate the

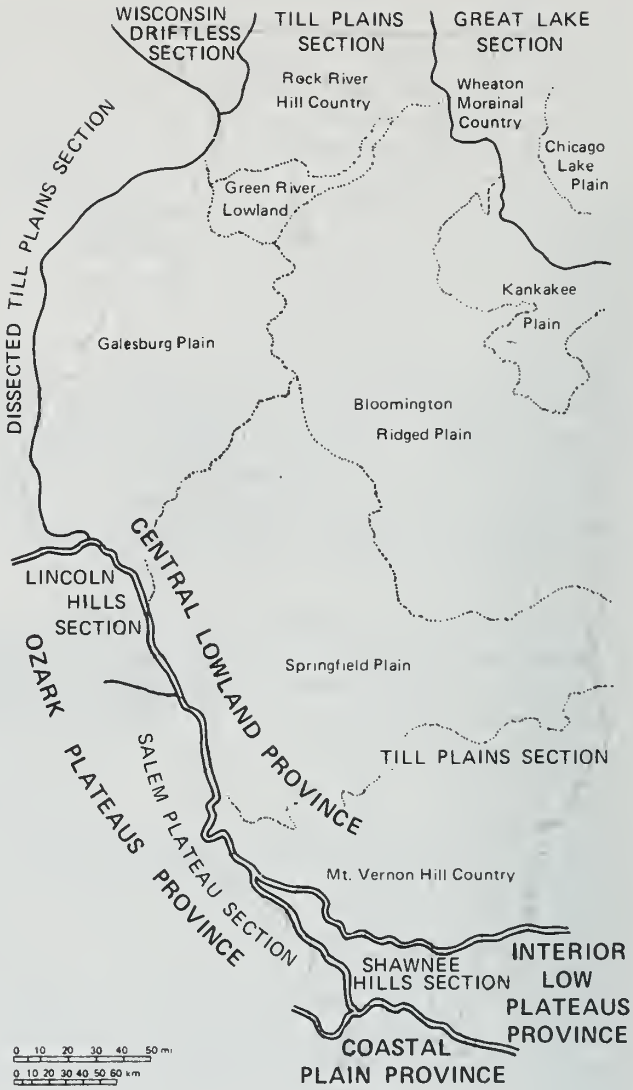


Figure 7 Physiographic divisions of Illinois.

valleys, but the valleys have steep gradients (bottom slopes) and narrow, v-shaped profiles with only very small flats developed alongside the streams.

South of the cuesta a plateau developed on the Mississippian strata much earlier in geologic time. This latter plateau is maturely dissected and the larger stream valleys are *alluviated*: only small, scattered patches of upland prairies remain; the valleys are much broader than those along the escarpment; gradients are quite low; and because of sediment buildup along their courses, the streams generally do not flow directly on bedrock. Local structure and varied lithology of the bedrock have influenced the courses of a number of streams here. Solution features (karst), such as sinkholes and no surface streams, are reflected in the local topography, especially where the underlying bedrock is the Mississippian Menard and St. Louis Limestones.

Drainage As noted previously, the field trip area is highly dissected by streams. North of the cuesta crest, streams near the northwest corner of the field trip area drain north and west toward the Mississippi River. East of that drainage divide, streams flow north and east through the Saline River drainage network into the Ohio River.

South of the Pennsylvanian escarpment in the central and southwestern part of the field trip area, drainage is via the Cache River to the Mississippi River. Drainage in the eastern field trip area is through Bay Creek and its tributaries into the Ohio River.

Relief The highest land surface along the rugged Ferne Clyffe field trip route is approximately 835 feet mean sea level (m.s.l.) elevation 0.5 mile east of the intersection of the I-57 turn-off and the Goreville Road. This elevation is about 230 feet lower than the elevation at Williams Hill, Pope County, the highest point in southern Illinois. The lowest elevation is a little less than 360 feet msl along the Cache River lowands west of West Vienna. Illinois' lowest m.s.l. elevation of 280 feet or so is at the confluence of the Mississippi and Ohio Rivers on the south side of Cairo. The total surface relief of the field trip area, calculated as the difference between the highest and lowest surfaces, is more than 475 feet. Maximum local relief is as much as 365 feet or so at several places along the Pennsylvanian escarpment.

Groundwater

Groundwater is a mineral resource frequently overlooked in assessment of an area's natural resource potential. The availability of this mineral resource is essential for orderly economic and community development. More than 48 percent of the state's 11 million citizens depend on groundwater for their water supply. Groundwater is derived from underground formations called aquifers. An **aquifer** is a body of rock that contains enough water-bearing porous and permeable materials to release usable quantities of water into an open well or spring. The water-yielding capacity of an aquifer can only be evaluated by constructing wells into it. After construction, the wells are pumped to determine the quality and quantity of groundwater available for use.

Because the Ferne Clyffe area was not covered by glaciers, and because outwash materials are not present here, water-yielding sand and gravel are also thin or absent. Only small supplies of groundwater for domestic supplies are available from the Pennsylvanian sandstones that occur in the escarpment. South of the cuesta, probabilities are fair to good that Mississippian sandstones and creviced limestones will yield suitable groundwater supplies for domestic purposes.

Mineral Production

Ninety-nine of the 102 counties in Illinois reported mineral production during 1987, the last year for which totals are available. The total value of all minerals extracted, processed, and manufactured in Illinois fell to $3.22 billion—1.3 percent lower than the 1986 total. This was the lowest value recorded since 1978, when the total was $3.17 billion.

Johnson County, which produced crushed stone used in construction and agriculture, ranked 69th among the counties producing minerals. Pope County, which ranked 99th in mineral production, produced fluorspar, lead, zinc, and silver but the totals are included in the Hardin County production figures without any breakdown. Saline County ranked third among the counties with production reported in coal, crude oil, and natural gas. Union County placed 57th in production of stone. Individual production figures are unavailable for these particular counties.

Trace Fossils

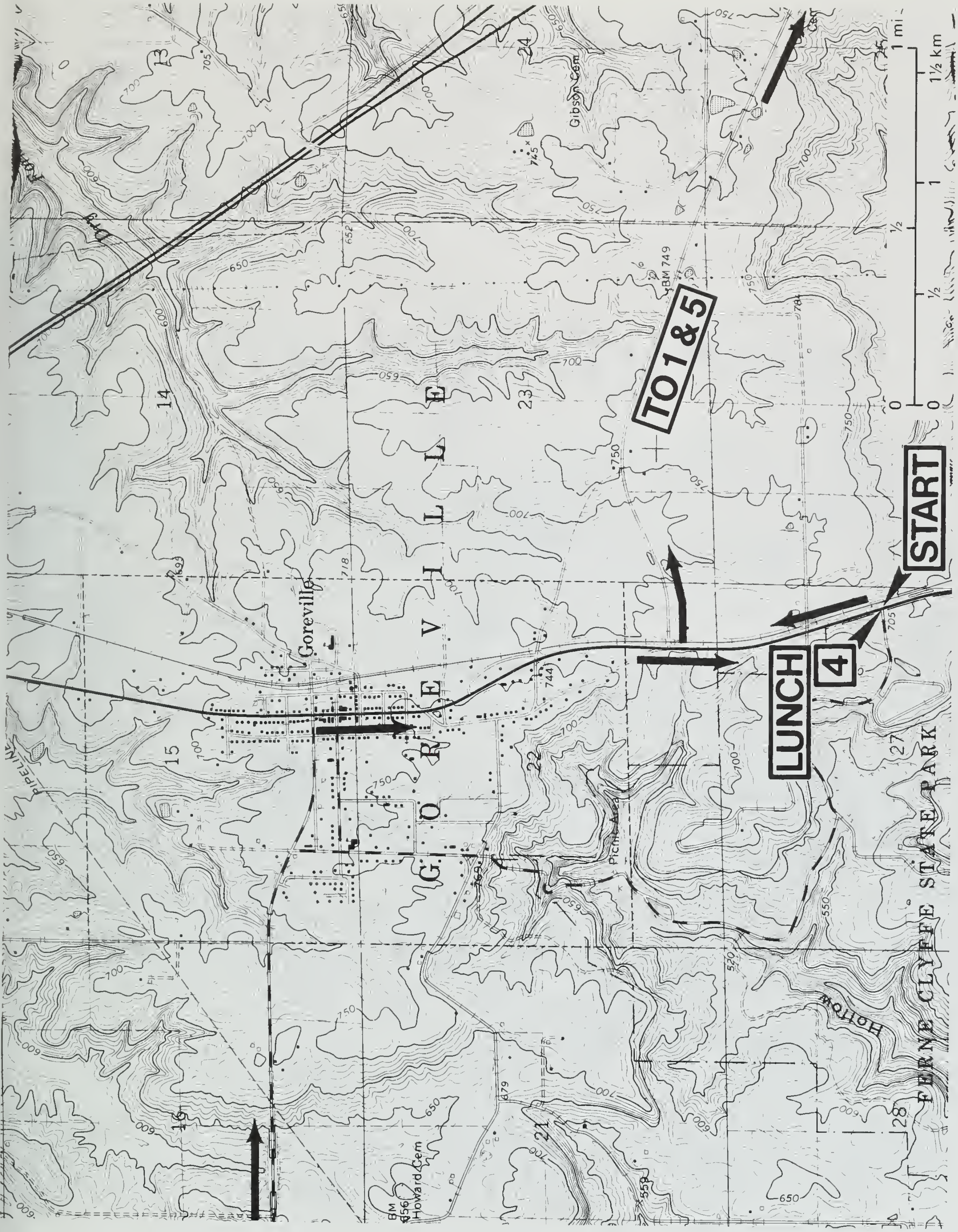
Four of the eight stops during this field trip give us an opportunity to look at preserved traces of animal activities—a trail, burrow, or resting place produced by organisms that lived millions of years ago. Trace fossils are also called ichnofossils. (*Ichnos* is the Greek term for footprint or track.)

By studying ichnofossils, geologists learn how ancient animals and plants lived and interacted with their environment. Ichnofossils also show us the shapes of organisms, such as sea anemones and worms, that are not generally preserved in the fossil record because they lacked hard parts.

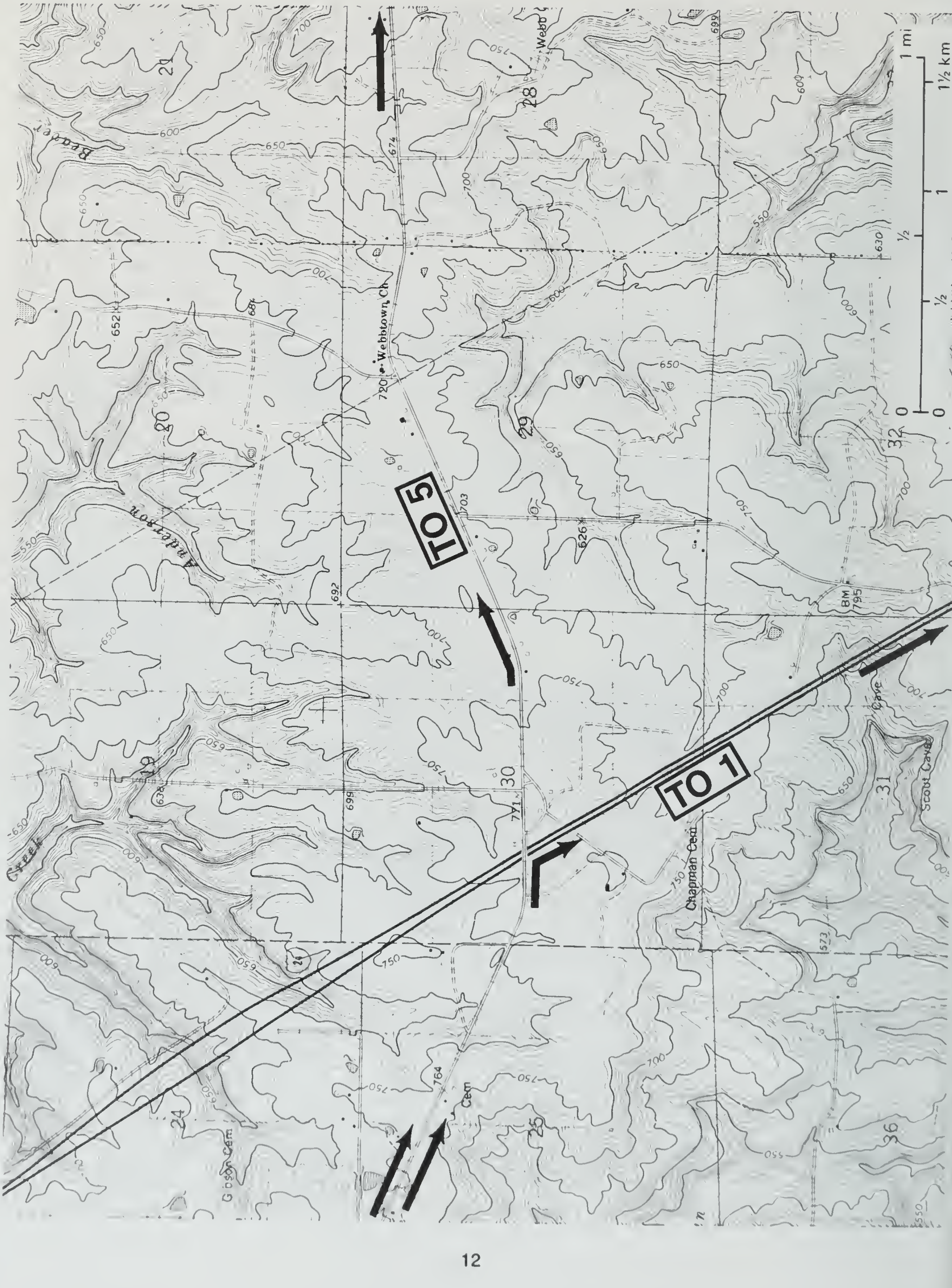
The trace fossil of a trilobite trail is like a "snapshot" showing the spatial relationships that existed during the origin of the trail. For example, 300 million years ago, a trilobite crossed a sandy rippled surface on the sea floor and left a trail. Shortly afterward the trail was buried by more sediment and became fossilized. Today, stream erosion has exposed the spot where the trilobite crossed. We can see where, how, and possibly why, the trilobite turned to avoid a certain obstruction.

Studying ancient animal behavior is not as easy with the plant, shell, and bone body fossils that are more commonly collected. Body fossils can be moved out of position after fossilization and reincorporated into younger sediments. This does not happen with trace fossils. Also, many trace fossils are found in rocks, such as the lower Pennsylvanian sandstones in the Illinois Basin, which have a relatively poor potential for preserving body fossils.

Trace fossils can help the geoscientist reconstruct ancient geographic settings, interpret buried environments and conditions of sedimentary deposition, and predict the location of resources. On this field trip, we will not only examine trace fossils, but also examine rocks for evidence of various depositional systems or ancient environments. We will visit and discuss (Stop 1) a paralic (coastal) swamp, (Stop 2) an ancient shallow sea; (Stop 3) a tidal channel and an *estuary* that is thought to be laterally equivalent to the 300-million-year-old swamp seen at Stop 1; and (Stop 7) a deltaic lobe with (Stop 8) a bay fill to the west of the deltaic lobe. We will also observe, and perhaps collect, some delicate traces left by soft-bodied organisms.



START
LUNCH
4
TO 1 & 5
Goreville
G O R E V I L L E
FERNE CLYFFE STATE PARK
Gibson Cem
Howard Cem
Picnic Area
PIPELINE
Hollow
13
14
15
16
21
22
23
24
27
28
0 1/2 1 mi
0 1/2 1 1½ km


TO 5
TO 1
Webbtown Ch
Webb
Chapman Cem
Gibson Cem
Cem
Cave
Scout Cave
Anderson
Beaver
Creek
BM 795
0
½
1 mi
0
½
1
1½ km

GUIDE TO THE ROUTE

Assemble in the Round Bluff/Lake View parking area at Ferne Clyffe State Park (SW SW SE NW Sec. 27, T11S, R2E, 3rd P.M., Johnson County, Goreville 7.5-minute Quadrangle [37088E8]*). The day will begin with botanists from the Illinois State Natural History Survey leading us on a short hike around Round Bluff to study the wild flowers.

Mileage calculations will begin at the park entrance and State Route (SR) 148. Please drive with your lights on while the caravan is moving. Turn them off when we park. Drive safely and stay as close as you can to the car in front of you. PARK CLOSE.

Miles to next point	Miles from start	
0.0	0.0	STOP (1-way); T-intersection with SR 148. Begin to keep track of your mileage. CAUTION: view of traffic is restricted. TURN LEFT (north).
0.5	0.5	Prepare to turn right.
0.1	0.6	TURN RIGHT (east) on Lake-of-Egypt Road beneath the Union Pacific (UP) and Burlington Northern (BN) railroad overpass. Signs on the righthand side of SR 148 point to I-24 and Lake of Egypt.
0.05	0.65	Cross the divide between the Cache River drainage to the south and west and the Saline River drainage to the east and north.
2.45	3.1	TURN RIGHT on the entrance ramp to I-24.
0.25+	3.35+	MERGE LEFT with south-moving traffic.
1.65+	5.0+	Road cuts through Caseyville Sandstone of Pennsylvanian age.
1.1	6.1+	CAUTION. Park on macadam shoulder as far off the roadway as you are able to safely.

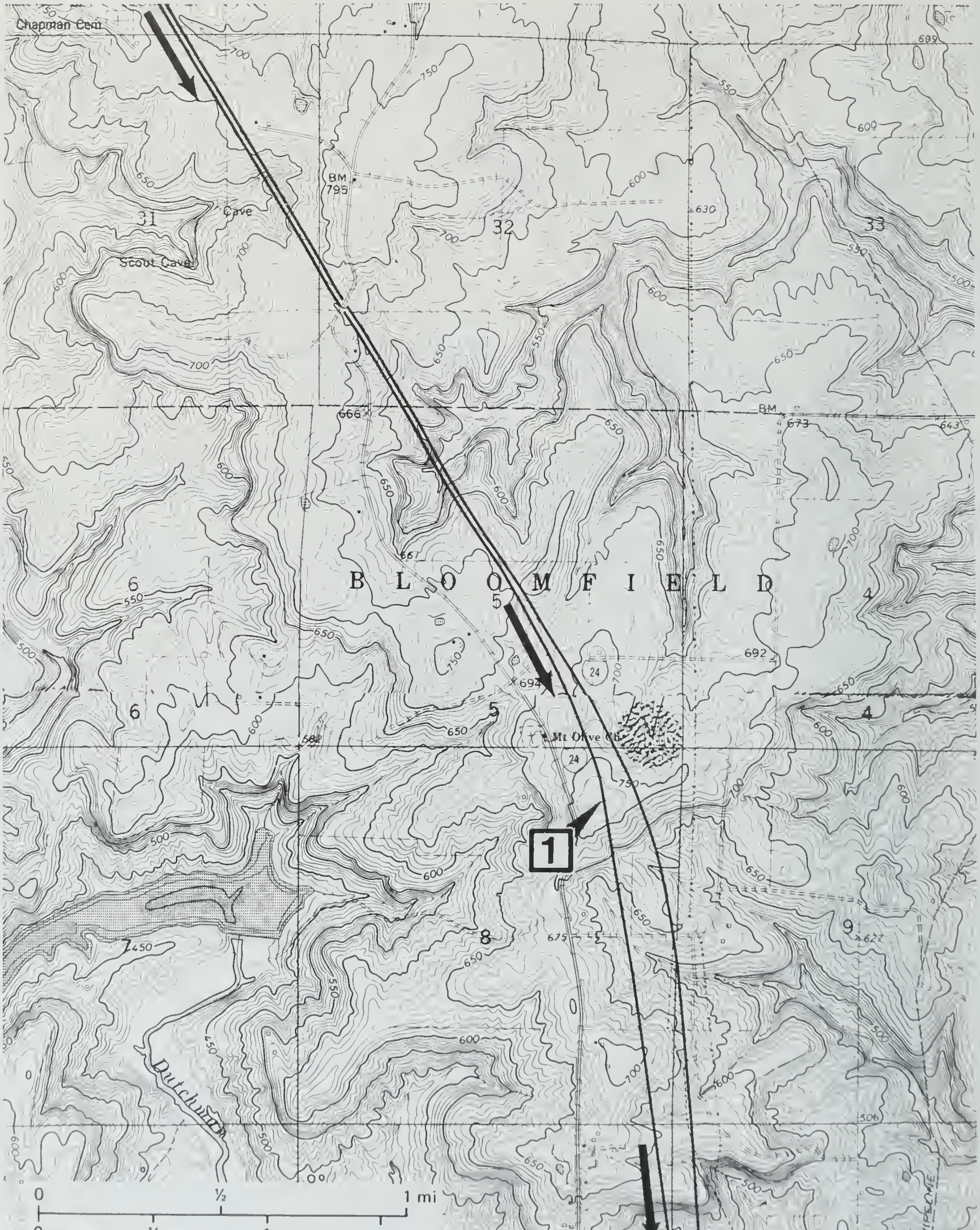
STOP 1. Examine the upper Caseyville and the overlying, lower Abbott Formations of lower Pennsylvanian age in a large I-24 roadcut exposure. The Abbott includes the Reynoldsburg Coal Member (SW NW NE NE Sec. 8, T12S, R3E, 3rd P.M., Johnson County, Vienna 7.5-minute Quadrangle [37088D8]).

Stratigraphy and Lithology

The lowest exposed sandstone in this roadcut is part of the Caseyville Formation. It is a white to tan, iron-oxide stained, fine-grained, fairly well-sorted quartz *arenite* with quartz granules and pebbles. Crossbedding is more apparent in the upper part of the exposure, whereas the lower part is thinly laminated.

The contact between the Caseyville and the overlying Abbott is gradational: it shows no discernible break between these two formations at this location. When two rock layers are in contact in this manner, they are said to be conformable.

* The number in brackets [37088E8] after the topographic map name is the code assigned to that map as part of the National Mapping Program. The state is divided into 1° blocks of latitude and longitude. The first two numbers refer to the latitude of the southeast corner of the block; the next three numbers designate the longitude. The blocks are divided into 64 7.5-minute quadrangles; the letter refers to the east-west row from the bottom, and the last digit refers to the north-south column from the right.


Chapman Cem
Cave
Scout Cave
BLOOMFIELD
Mt Olive Ch
1
0 ½ 1 mi
0 ½ 1 1½ km

The basal Abbott Formation is a reddish shale that contains numerous plant fossils. *Stigmaria* (fossil roots) are common in the silty underclay of the Reynoldsburg Coal just above the red shale. The coal is bright banded, stained yellow, and up to 27 inches thick. Directly above the coal is a 3-foot-thick siltstone/sandstone unit that contains *Lepidodendron* and *Sigillaria* plant debris. Overlying and conformable with the siltstone is a light brown sandstone that is more than 10 feet thick. Sheet sands and large-scale trough stratification are the primary sedimentary structures. Sandstone-filled cracks (*desiccation* cracks) can be observed near the top and in the fallen float blocks of the sandstone.

Ichnology

High-angle escape structures (fig. 8) that are backfilled occur in the Abbott sandstones in the upper part of the roadcut. These structures formed as an organism moved upward and out of the sandy sea floor, and sand filled in behind it. Escape traces as well as resting and crawling traces of the same trace-maker can be seen along the bedding planes of the sandstones. All were made by small bivalves (clams). The resting and crawling traces are called *Lockiea* sp. (figs. 9 and 10). Escape structures are collectively called fugichnia. These high-angle traces are *Lockiea* fugichnia. No other trace fossils have been found at this location within the sheet sands.

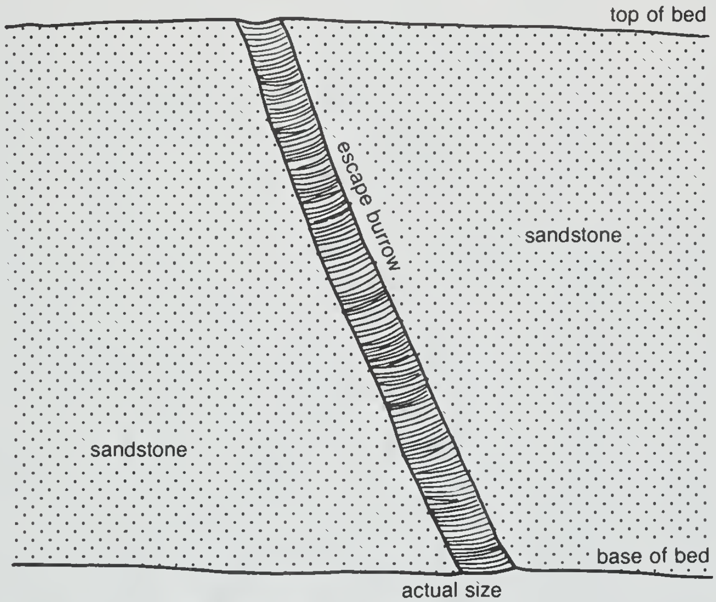
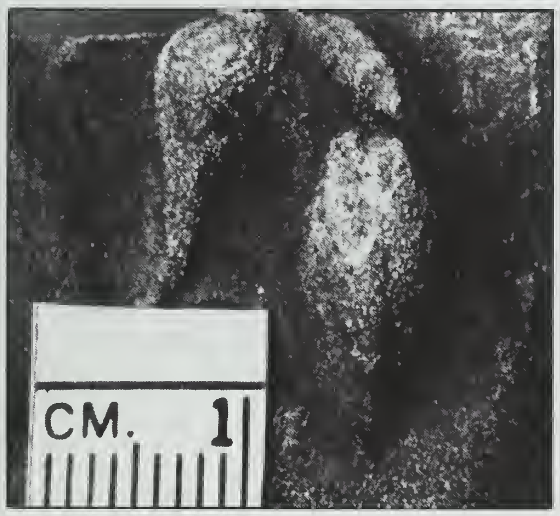
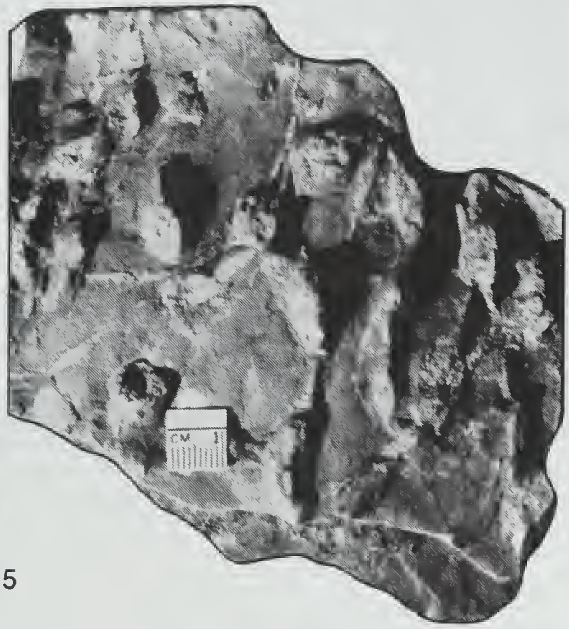


Figure 8 *right*
Ichnofossil: escape burrow.

Figure 9 *below left*
Lockeia: resting traces.

Figure 10 *below right*
Lockeia: resting traces.



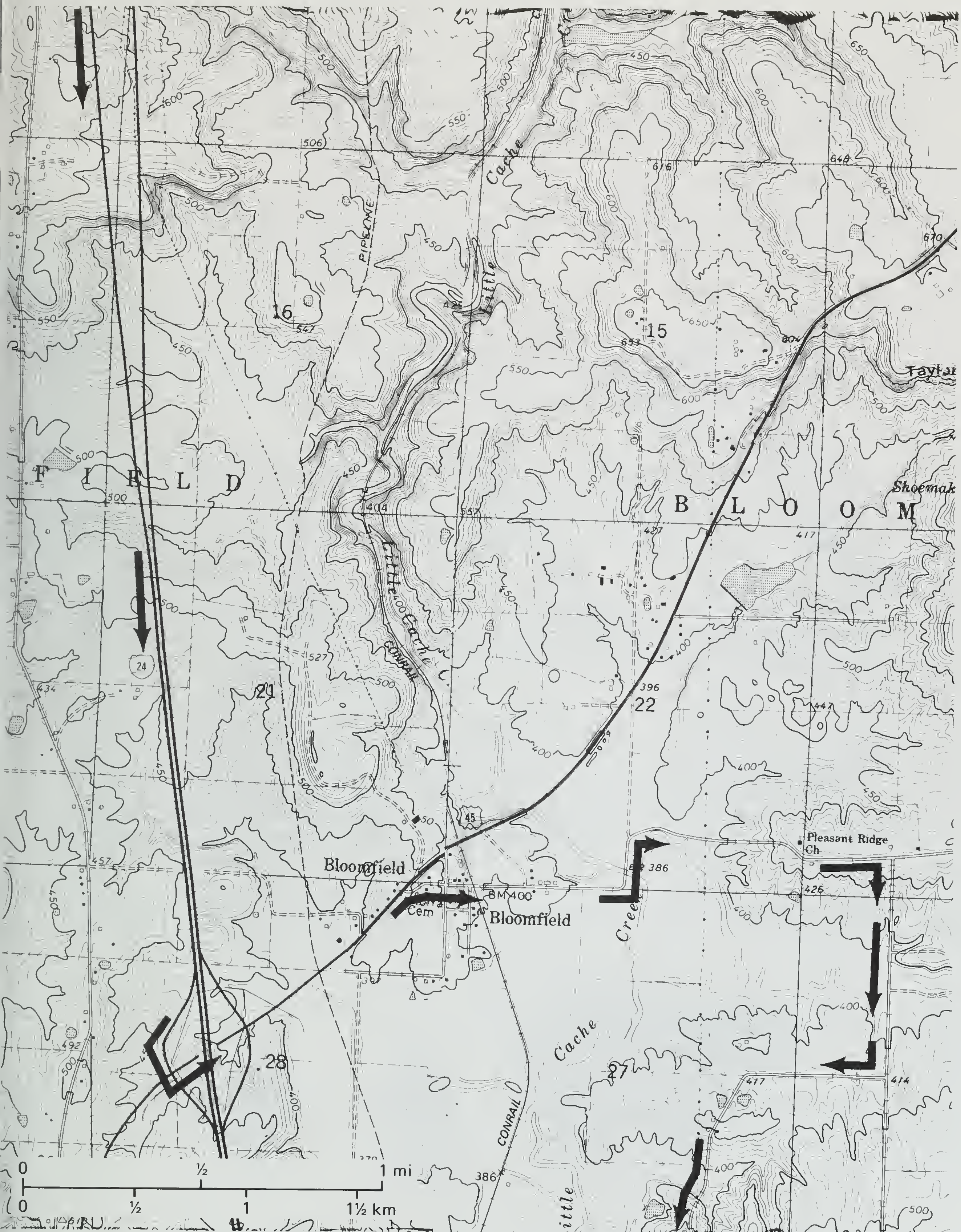


Interpretation of the Silt/Shale/Coal Sequence Between the Sandstones

Yellow stains in the coal, called "yellow boy" by some miners, are due to oxidized sulfur. The origin of much of this sulfur in the coal was sulfate ions dissolved in sea water, either from an ancient peat swamp near the sea or from salt water leaching the sulfate from porous rocks, then depositing it after the coal had formed. In the case of the Reynoldsburg Coal, the sulfur was probably introduced during deposition.

Marine algae can also be found in the coal—evidence for the theory that this coal was deposited in a coastal swamp. The sedimentology and ichnology of horizontally equivalent rocks nearby (10 miles to the northwest) also indicate a marine origin. An estuary to the west is thought to be at the same horizon as this coal. We will see this estuarine environment at Stop 3. (For more information about the depositional history of Pennsylvanian rocks in Illinois, refer to the appendix at the back of the guide leaflet.)

0.0	6.1+	Leave Stop 1. CONTINUE AHEAD (southward).
1.0+	7.1+	Lower Caseyville Formation is exposed in this roadcut.
2.1+	9.25+	Prepare to turn right.
0.1+	9.35+	TURN RIGHT (southwestward) at Exit 14.
0.3	9.65+	STOP: 1-way. TURN LEFT (northeastward) on US 45. CAUTION: divided highway.
0.1+	9.75+	I-24 overpass.
0.6	10.35+	Prepare to turn right.
0.1+	10.5	TURN RIGHT (east) at the sign (880E) pointing toward Pleasant Ridge Church.
0.2+	10.7+	Caution: unguarded single track of the Southern Railroad (SR).
0.45+	11.15+	Cross Little Cache Creek.
0.1	11.25+	BEAR RIGHT (east) at T-road intersection (1115N/950E).
0.45+	11.75+	Pleasant Ridge Church to the left.
0.25+	12.05	TURN RIGHT (south) at T-road intersection (1110N/1025E). The area ahead is underlain by Menard Limestone of Mississippian age.
0.6+	12.65+	TURN RIGHT (west) at T-road intersection (1050N/1025E).
0.15	12.8+	Small sinkholes, especially noticeable to the right of the road, were caused by solution of the Menard Limestone. Sinkhole topography needs four conditions for development: (1) soluble rock, essentially horizontal, at or near the surface; (2) the rock must be dense, highly jointed, and preferably thinly bedded; (3) major valleys must be deeply entrenched to act as outlets for groundwater; and (4) ample rainfall must be available.
1.85+	14.65+	STOP: 1-way (895N/975E). TURN RIGHT (southwest) on SR 147.



FIELD
BLOOM
Little Cache
Cache
PIPELINE
CONRAIL
Bloomfield
Pleasant Ridge Ch
Cache Creek
Taylor
Shoemak
16
15
21
22
27
28
24
45
BM 400
0
½
1 mi
0
½
1
1½ km

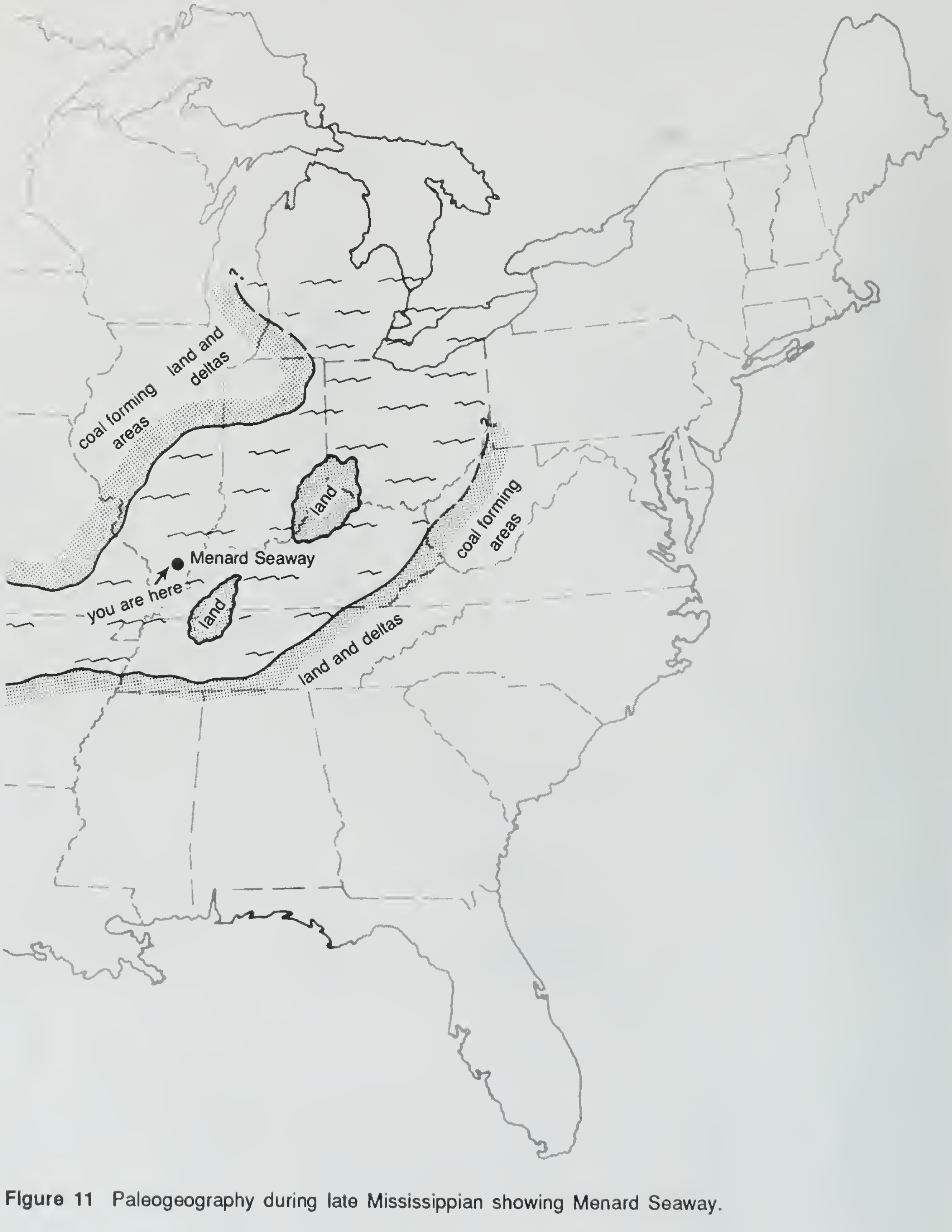


Figure 11 Paleogeography during late Mississippian showing Menard Seaway.

0.6+	15.3+	STOP: 1-way. TURN RIGHT (west) on SR 146 (840N/950E).
0.15+	15.45+	CAUTION: northbound I-24 access ramp to right.
0.05	15.5	West of the access ramp, PARK as far off the roadway as you can safely. WALK to the rock exposure along the access ramp. USE EXTREME CAUTION in this area.

STOP 2. View Mississippian Menard Limestone exposure along the east and northeast sides of the I-24 access ramp (NW NE SW Sec. 3, T13S, T3E, 3rd P.M., Johnson County, Bloomfield 7.5-minute Quadrangle [37088D7]).

Stratigraphy
The roadcut on the I-24 ramp exposes an upper Chesterian unit called the Menard Limestone (fig. 3). We are looking at rocks that are lower than those exposed at Stop 1 in the stratigraphic column of the Illinois Basin. The Mississippian rocks exposed here are about 20 million years older than the Pennsylvanian rocks observed at Stop 1.

Interpretation of the Mississippian Environment
About 320 million years ago, a shallow ocean covered this location (fig. 11) and much of Illinois, Indiana, and Kentucky. Attached to the sea floor were crinoids, blastoids, and lattice-like fenestrate bryozoans (fig. 12 a, b, c). During this period, the Mississippian, trilobites were smaller than they were during earlier geologic times and on their way to extinction during the Permian Period.

Brachiopods lived in clusters. Bivalves (clams) also were present. Occasionally, large shell-crushing sharks tore up bits of the sea floor and filtered out the shelled animals from the limy mud. These sharks smashed the shelled creatures with their pavement-like teeth and digested the delicate parts of these organisms.

The ocean became cloudy at times either from storms churning up the seafloor or from clay being washed from deltas into the sea. The fine clay material settled out and is now preserved as the shaly intervals commonly seen in the Menard today. When the sea was less cloudy, relatively clean limestone formed. Some limestone strata consist of animal graveyards where countless skeletons of ancient invertebrates were transported and dumped. These types of limestones are called packstones or grainstones, depending on the amount of fine mud mixed in with the shell fragments.

The types of animals that lived here—corals, bryozoans, crinoids, and blastoids—tell us that the sea was warm and tropical.

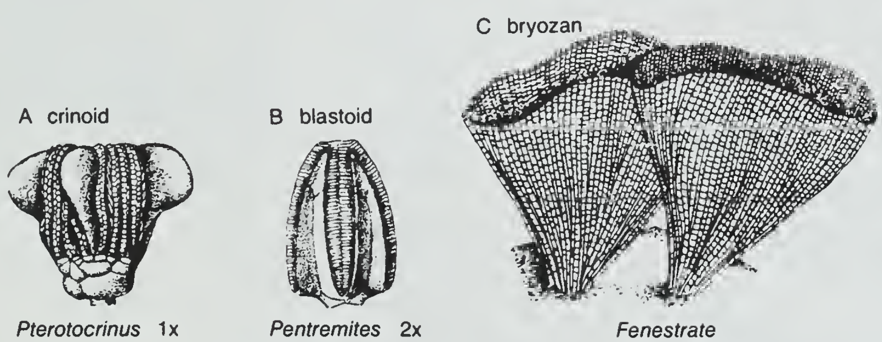
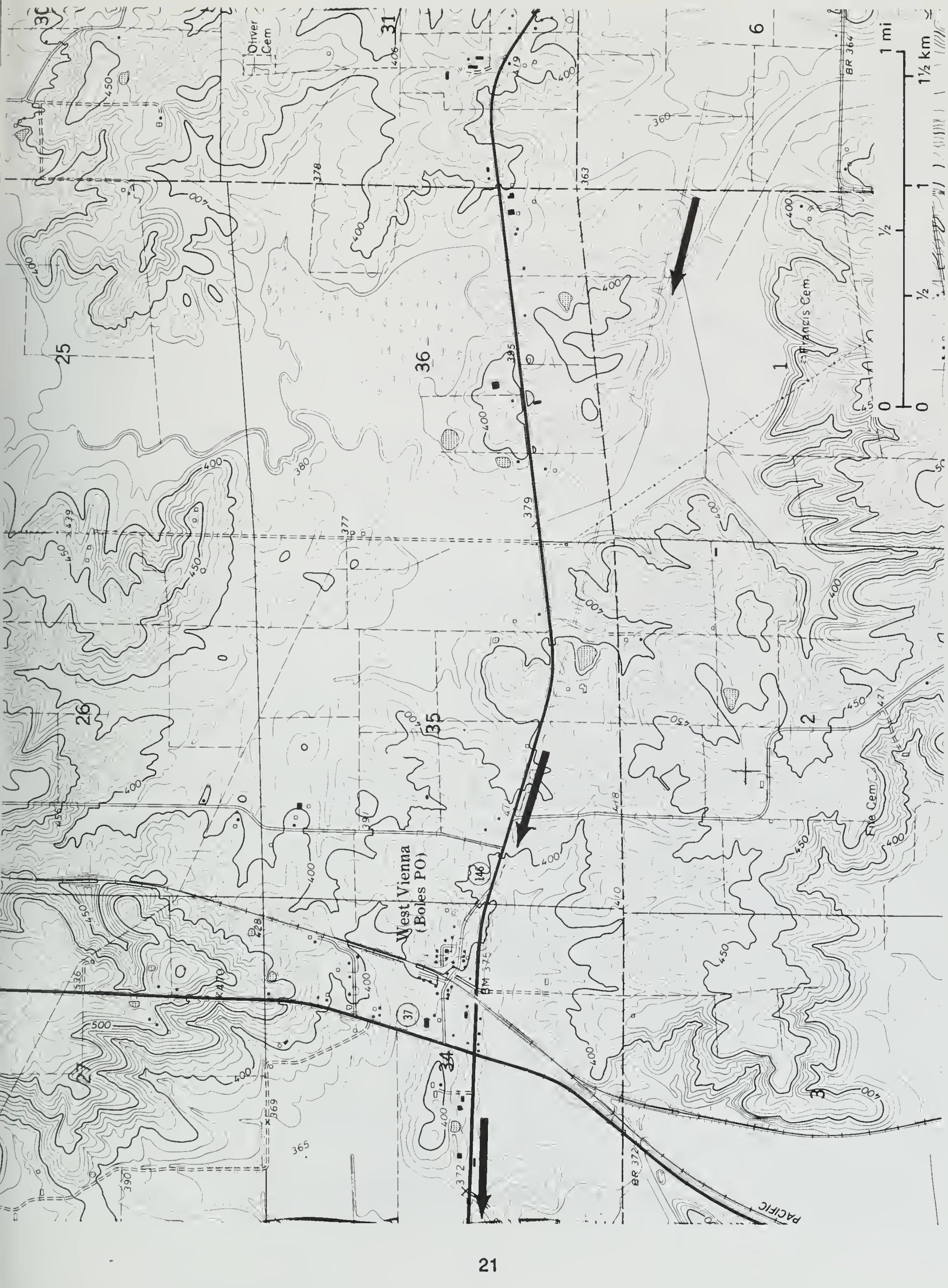
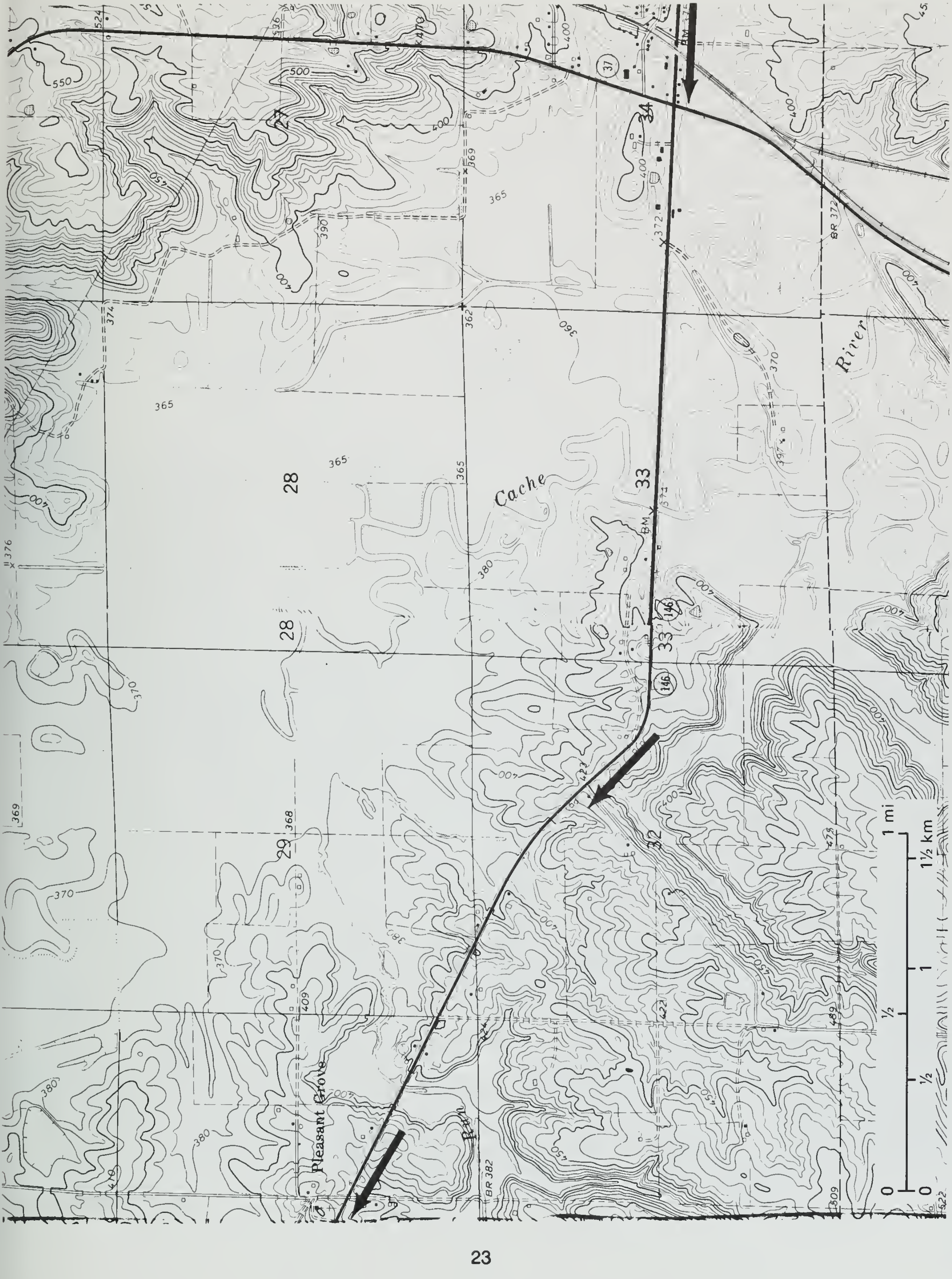


Figure 12 Some Mississippian fossils: *A* crinoids, *B* blastoids, and *C* fenestrate bryozoans.


Vienna
(BM 404)
Fairground
Reservoir
Vienna
Cemetery
CONRAIL
PIPELINE
Little
Cache
McCorkle
Creek
Creek
BR 370
BM 372
BM 389
Stewart Cem
2
1 mi
1½ km


West Vienna
(Boles PO)
Oliver Cem
Francis Cem
PACIFIC
1 mi
1½ km
25
26
27
31
34
35
36
1
2
3
6

0.0	15.5+	Leave Stop 2. CONTINUE AHEAD (west).
0.1+	15.6+	I-24 overpass. CONTINUE AHEAD (west).
0.45+	16.05+	Enter Vienna. Stay on SR 146.
0.4	16.45+	CAUTION: two, guarded (SR) tracks.
0.25	16.7+	Cross Little Cache Creek.
0.1+	16.85	STOP: 4-way; US 45 junction with SR 146. CONTINUE AHEAD (west) on SR 146 along north edge of the business district.
4.3+	21.15+	UP/BN RR overpass.
0.15	21.3+	STOP: 4-way junction with SR 37. CONTINUE AHEAD (west) on SR 146.
1.0	22.3+	The lowlands along the highway here have the lowest surface elevations in the field trip area.
0.1+	22.45+	Cross Cache River.
1.85+	24.3+	Cross Buck Run.
0.4+	24.75+	West of the cemetery, you can see Cedar Bluff to your right, about 5.5 miles to the north. The bluff is part of the south-facing Pennsylvanian escarpment.
0.7+	25.5	Enter Union County. As you travel westward, you will have several opportunities to view the Pennsylvanian escarpment to the north.
4.75	30.25	Historical marker to the left commemorates a Cherokee Camp: "During January, 1839, thousands of Cherokee Indians, en route from Georgia to Indian Territory and unable to cross the Mississippi because of floating ice, were encamped one mile north of here. Unprepared for the intense cold, nearly 2,000 of the 13,000 Indians who started lost their lives during the journey." This location is also the second burial site of "King Neptune" (1941-1950), a famous Navy mascot pig—the focus of a campaign that raised $19 million in World War II War Bonds from 1941-46.
0.5	30.75	Prepare to turn right.
0.15+	30.9	TURN RIGHT (north) onto I-57 access ramp.
0.2+	31.1+	CAUTION: merge left into traffic moving north on I-57.
1.9	33.0+	Cross Cache River.
3.9	36.9+	Lick Creek exit. CONTINUE AHEAD (north) on I-57.

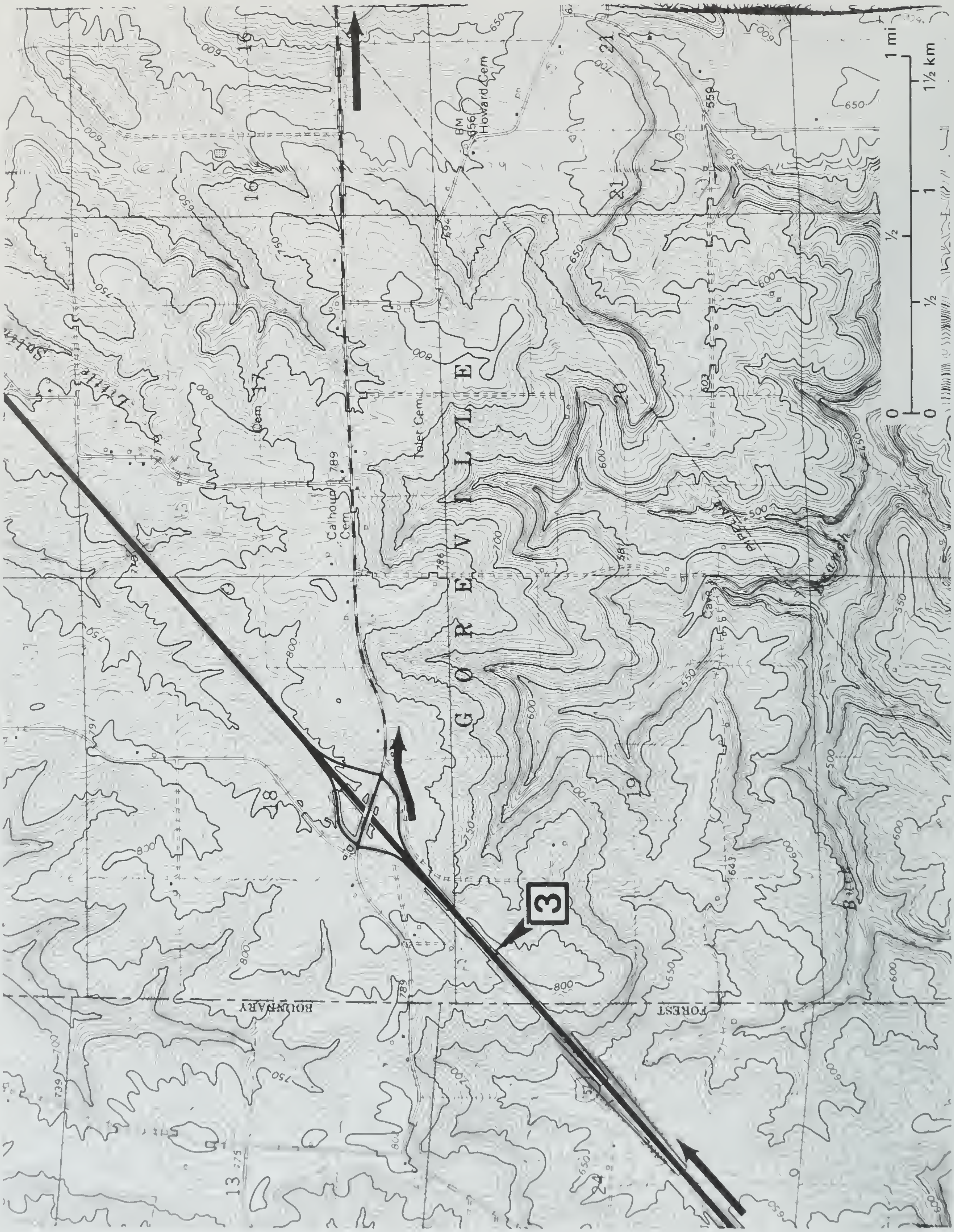

Cache
River
Pleasant Grove
Run
0
½
1 mi
0
½
1
1½ km


Pleasant Grove
Mt Pleasant
Mt.Pleasant Ch.
Buck
Run
BR 382
BR 472
BM
481
BM
514
1 mi
1½ km
0
½
1


McGinnis Cem
BM 549
Campground Ch.
Creek
146
0 ½ 1 mi
0 ½ 1½ km


T. 12 S.
4153
Bradshaw
Creek
Lick Creek Sch
BM 528
PIPELINE
BR 417
2 LANE
BM
406
Bradshaw
Cache
New
Ch
0
½
1 mi
0
½
1
1½ km


N A L F O R E S T
Lick Creek
Lick Creek Ch
Buck Knob
Ford
Pumping Station
PIPELINE
Lick Creek
BR 416
BR 411
22
23
24
25
26
27
34
35
36
3
2
0
½
1 mi
0
½
1
1½ km


GOREVILLE
Calhoun Cem
Howard Cem
Toler Cem
Cem
BM 656
BOUNDARY
FOREST
3
0 ½ 1 mi
0 ½ 1 1½ km

1.0	37.9+	To the right (east), view Drapers Bluff, also a part of the Pennsylvanian escarpment. The bluff is nearly 365 feet high.
0.05+	37.95+	Cross Lick Creek and ascend the escarpment through the long roadcuts.
1.9	39.85+	Enter Johnson County and prepare to park along road shoulder.
0.15+	40.05	PARK well off the roadway on the paved shoulder. DO NOT CROSS I-57 EXCEPT WITH THE GROUP. Stay BETWEEN the parked cars and the rock faces. Please DO NOT CLIMB to the top of the rock cuts.

STOP 3. Discuss the influence of tides on the gradational nature of the Caseyville/Abbott Formation contact in the upper (northern) roadcut (NW NW extended Sec. 19, T11S, R2E, 3rd P.M., Johnson County, Lick Creek 7.5-minute Quadrangle [37089E1]).

Location and Stratigraphy

A 1-mile long roadcut on I-57 south of the Goreville exit exposes a shaly interval sandwiched between two crossbedded sandstone units. The shaly middle portion is composed of a dark gray and purple, sandy, silty shale. This shale and overlying sandstone compose the basal Abbott Formation. The sandstone below the shale is the Caseyville Formation.

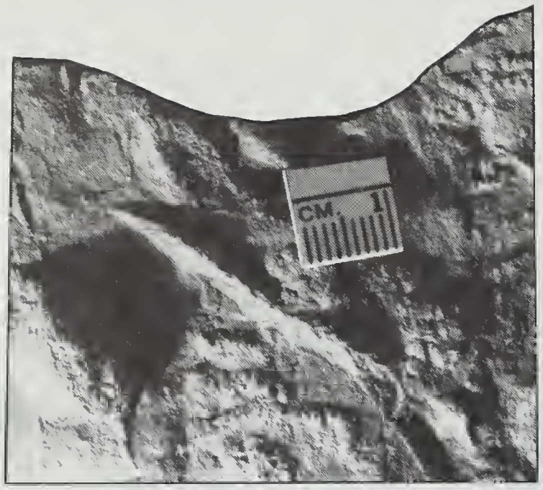
Ichnology

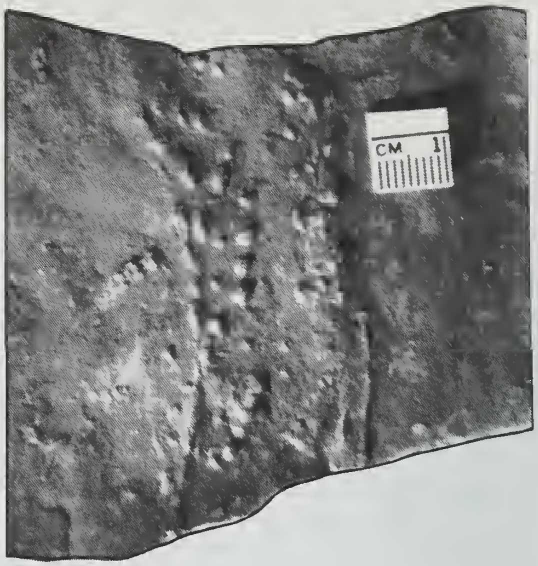
The most abundant trace fossil in the shaly portion of this roadcut is an unnamed arthropod resting trace (fig. 13). They all occur parallel to the ancient current direction and perpendicular to ripple crests in the sandy shales. Almond-shaped *Lockeia* with *Uchirites* (crawling trace fossil) and rare trackways of *Kouphichnium* (horseshoe crabs) have also been found in the shales (figs. 14 and 15).

Interpretation of the Shale Interval

The shale interval here is laterally equivalent to the Reynoldsburg Coal of Stop 1. We are about 10 miles to the northwest of Stop 1, but the environment was quite different at this location 300 million years ago. Biota (flora and fauna) that lived here indicate marine or brackish (between marine and freshwater) conditions. We can see trails of horseshoe crabs, which thrive in brackish water today. The high abundance and low diversity of organisms also indicate a nearshore brackish water environment. Current-directed traces, such as ripple marks, climbing ripples, flute casts, and flaser structures, strongly suggest that the dominant water flow was to the west and south. The rocks also indicate high sedimentation rate as seen by climbing ripples but moderate to low energy in water flow because of the presence of so much clay in this system. All evidence points to an estuarine environment (fig. 16).

Figure 13 Unnamed arthropod resting trace.





Figures 14 and 15 Trackways made by koupichnium.

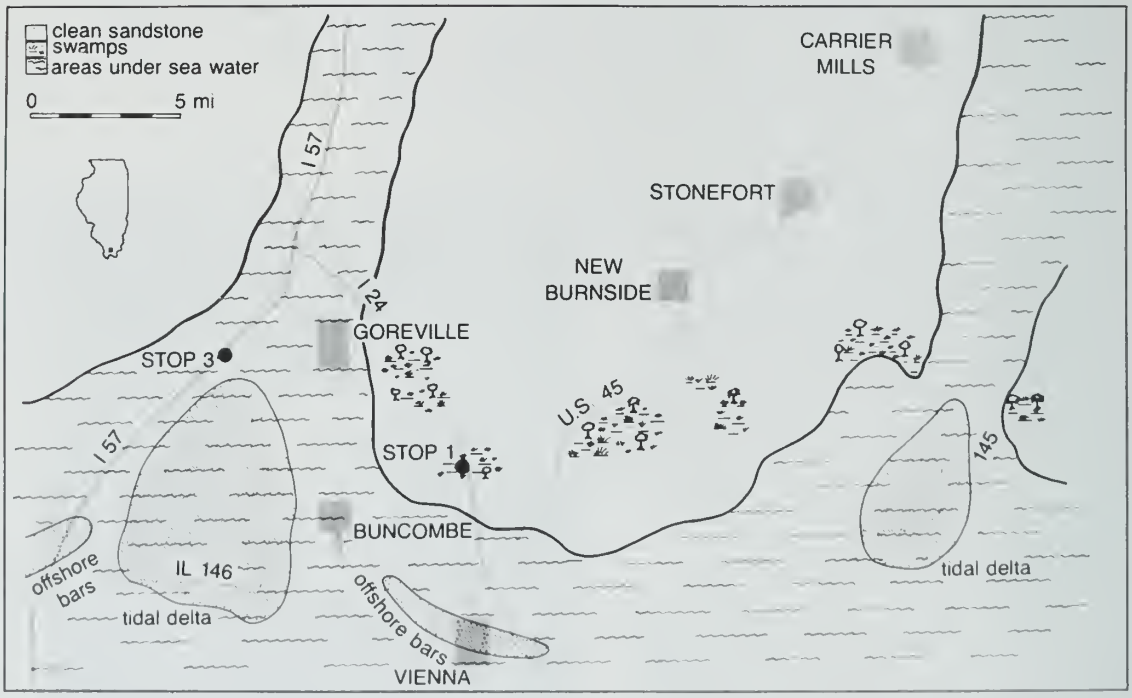
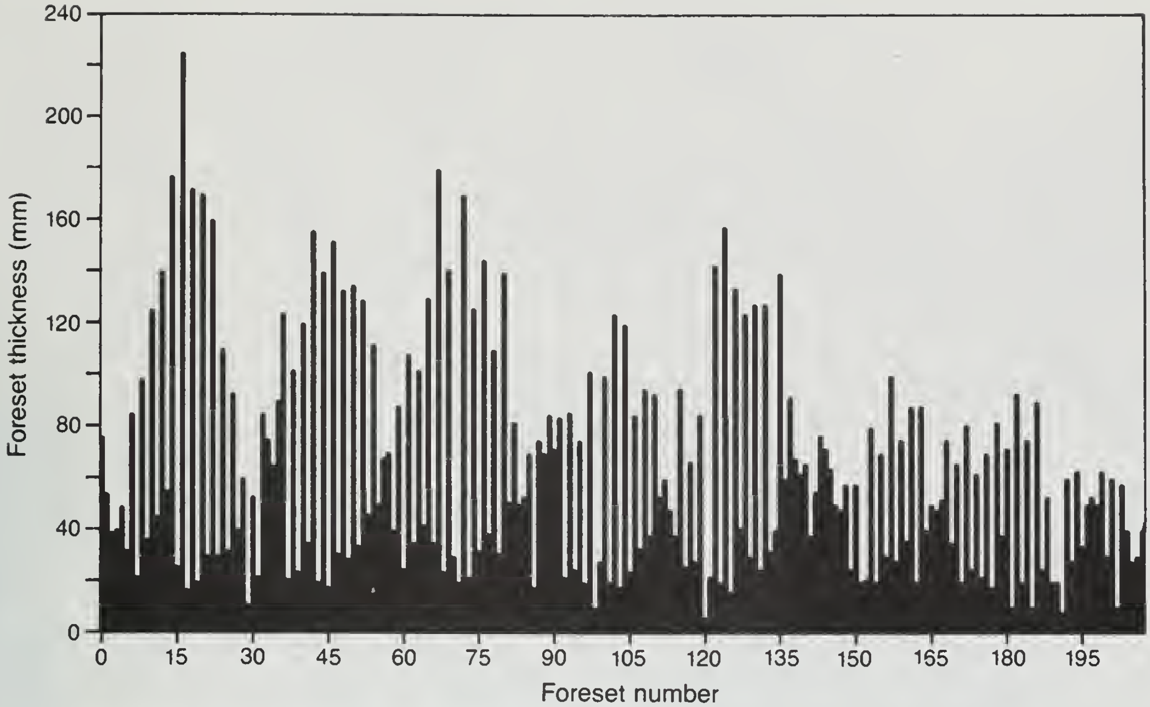


Figure 16 Paleogeographic setting of field trip area during early Pennsylvanian time. At Stops 1 and 3, we will examine sediments deposited during this time. Present-day geography is shown in background for scale.



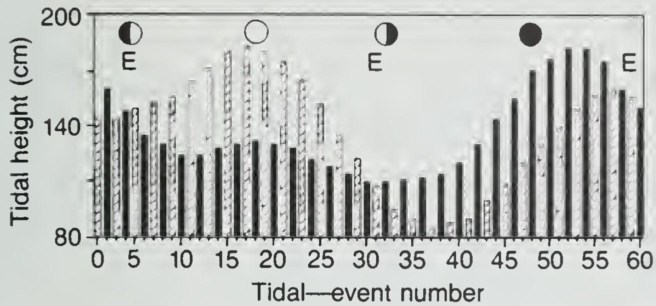


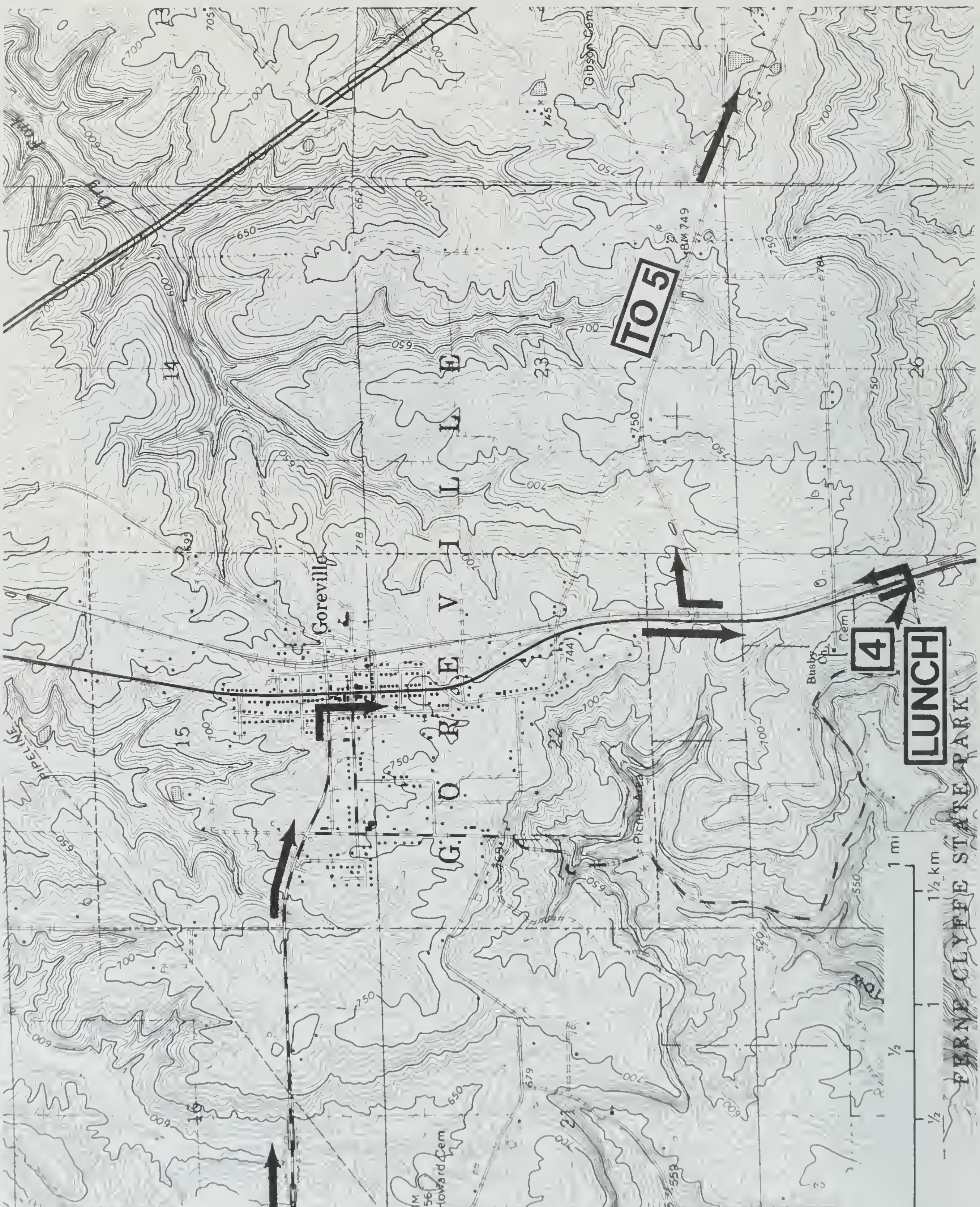
Figure 17 Foreset thickness variability within a part of the upper sandstone (Pennsylvanian) in the I-57 roadcut at Stop 3 (from Archer et al. 1989).

Figure 18 Tidal patterns from Boston, Massachusetts, during January 1963 (from Harris 1981).

Interpretation of the Upper Sandstone

Another interesting paleoenvironment can be observed in the upper sandstone at this roadcut. Evidence that tides once influenced these sandstone beds can be seen in the rhythmic pattern of the crossbed thickness. Each crossbed set alternates from thick to thin. These sets were probably deposited in a semidiurnal tidal cycle of one thick-thin couplet per day: the thicker, dominant part was deposited during high tide and the thin, subordinate part, during low tide.

Thickness of a sequential package of couplets varies systematically down the roadcut. The imprint of larger cycles of crossbed sets, which also thicken and thin down the roadcut, may be related to *neap* and *spring* tidal events (Kvale and Ullin, 1988; Archer, et al, 1989). The thickest crossbed couplet occurs approximately every 29th event (fig. 17). This sequence is compared to a graph of a present-day tidal pattern from Boston, Massachusetts (fig. 18). The regularity of sedimentation supports the tidal interpretation. A lag of clay pebbles at the base of these sandstone units supports the interpretation of an erosional channel that was migrating to the south and flowing east-west. This environment was probably a tidal channel. More tidal channels are recorded in these sandstones. How many are exposed here?


G O R E V I L L E
Goreville
TO 5
4
LUNCH
FERNE CLYFFE STATE PARK
Gibson Cem
Howard Cem
Busby
Cem
PIPELINE
BM 749
14
15
16
21
22
23
26
0
½
1 mi
1½ km

0.0	40.05	Leave Stop 3. USE CAUTION in pulling back onto the highway.
0.35	40.4	TURN RIGHT at the Goreville Road off-ramp (Exit 40).
0.25	40.65	STOP: 1-way. TURN RIGHT (east) toward Goreville. Note: just after turning onto the Goreville Road, you will find the entrance road to the Scenic Overlook. Later, you may wish to visit here and enjoy the view southward from the top of the Pennsylvanian escarpment. CONTINUE AHEAD (east) toward Goreville.
0.5	41.15	This rise is approximately 835 feet m.s.l. in elevation, the highest on the field trip. Note the more gentle surface slopes to the left (north) as we travel ahead. This is the dipslope or backslope of the Pennsylvanian escarpment (cuesta).
1.3+	42.45+	For the next 0.2 mile, our route crosses an arm of what was glacial Lake Little Saline, which had a surface elevation of approximately 650 feet and extended south for about 0.5 mile.
0.75	43.2+	Enter Goreville.
0.65	43.85+	STOP: 2-way. TURN RIGHT (south) on North Broadway (SR 37).
1.5	45.35+	Prepare to turn right.
0.1+	45.5+	TURN RIGHT (west) at the entrance to Ferne Clyffe State Park. CONTINUE AHEAD westward to the lake area and then turn northwestward into the lower park area near Big Rocky Hollow parking and picnic area (SE NW SW Sec. 22, T11S, R2E, 3rd P.M., Johnson County, Goreville 7.5-minute Quadrangle [37088E8]).
		After lunch, calculate your mileage again from the park entrance.

STOP 4. Lunch. After lunch, you will have an opportunity to look at the rocks and curious weathering features of the rocks. Biologists from the Illinois State Natural History Survey will show you more wild flowers and a rock shelter.

Lithology

Ferne Clyffe is dominantly composed of sandstones of the Caseyville Formation; they are quite thick because they contain many coalescing sandbodies. The sandstones are well to poorly sorted, range from fine to coarse grained, and commonly contain large, well-rounded quartz pebbles. The Caseyville has a sugary appearance and typically weathers gray or tan with iron-oxide stains. Crossbedding and tabular bedding that can be quite thick are common sedimentary structures of the Caseyville.

Interpretation of the Pennsylvanian Environment

The origin of the Caseyville was thought to be mainly fluvial (river deposits). Within the last 5 years, this idea has been challenged. Recent evidence shows that a larger percentage of the Caseyville was deposited in nearshore, brackish to marine conditions (paralic) (Devera 1986, Devera et al. 1987, Devera 1989). Evidence from trace fossils, sedimentology, and the geometry of these sandstones all supports the paralic deposition of these rocks (fig. 19).

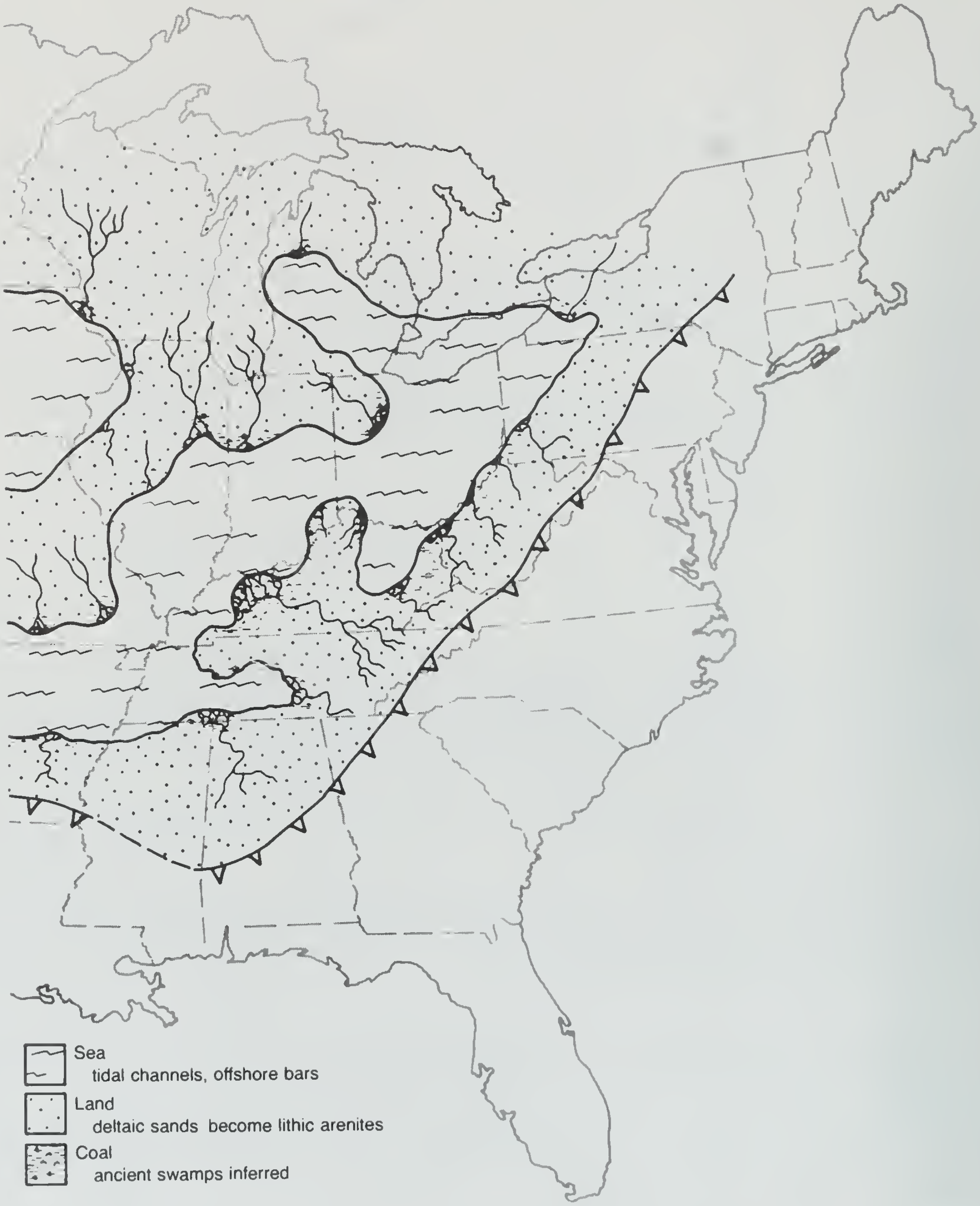
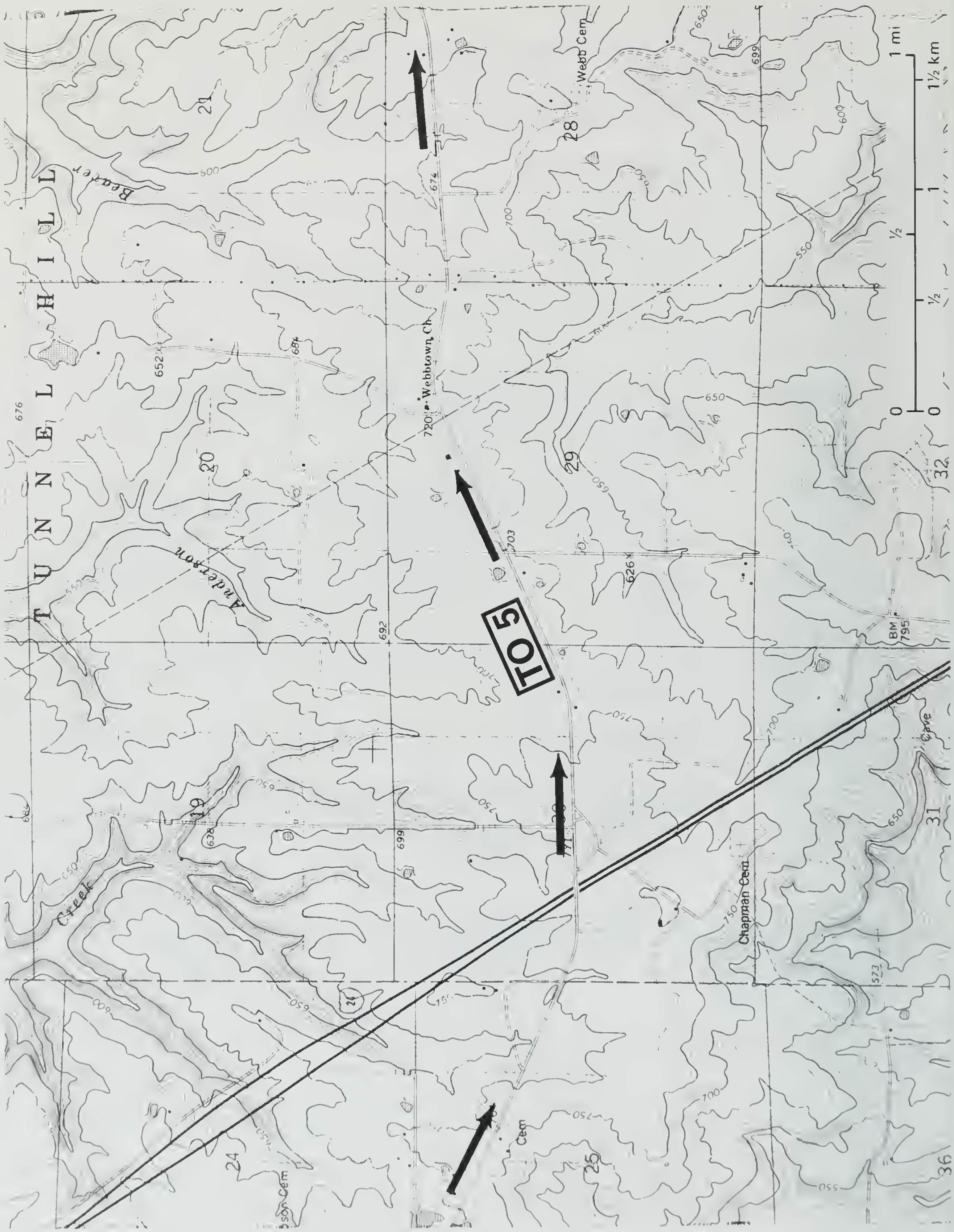
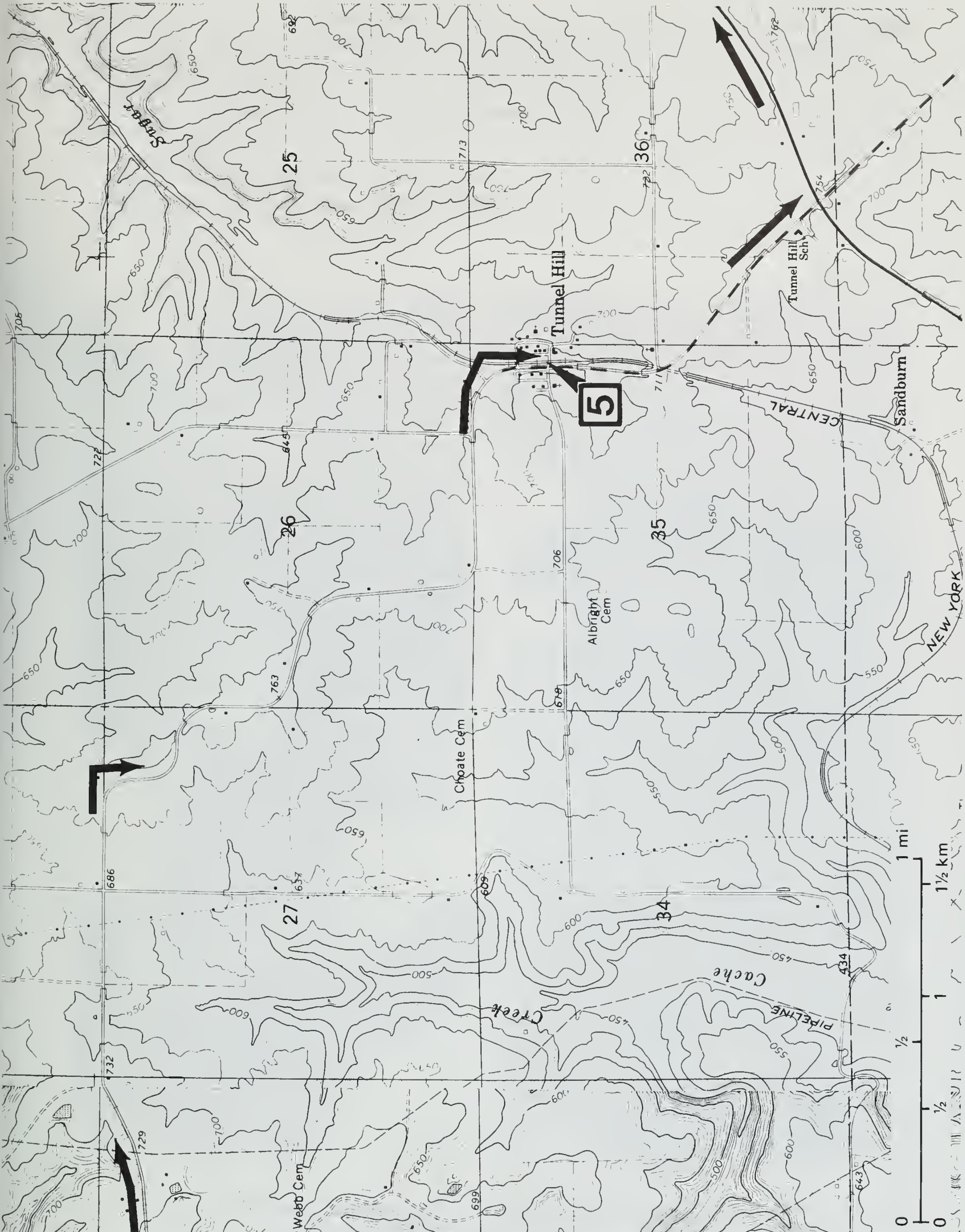


Figure 19 Paleogeography during Caseyville deposition (late Morrowan).

		Retrace route back to park entrance. Leave Stop 4.
0.0	45.5+	STOP: 1-way at park entrance. **Caution:** somewhat restricted visibility from both directions. TURN LEFT (north) on SR 37.
0.5	46.0+	Prepare to turn right.
0.1	46.1+	TURN RIGHT (east) on Lake of Egypt Road, beneath the UP/BN railroad underpass.
2.5	48.6+	I-24 access ramp: CONTINUE AHEAD (east) on Lake of Egypt/Tunnel Hill Road.
0.1	48.7+	Cross I-24.
2.15+	50.9	Cross Beaver Creek (tributary ?). Glacial Lake Wagon (fig. 6) with a surface elevation of about 550 feet m.s.l. was present about 0.8 mile north of here.
0.35+	51.25+	Trunkline Gas Company pipeline crossing: pipelines 26, 30, and 36 inches in diameter extend from Joppa on the Ohio River north-northeastward across the southeastern tip of Iroquois County and into Indiana.
2.7	54.0+	CAUTION: descend steep hill into hamlet of Tunnel Hill and prepare to turn left.
0.2+	54.25+	CAUTION: TURN LEFT (east) across abandoned SR tracks.
0.05-	54.3	TURN RIGHT (south).
0.05+	54.35+	TURN RIGHT (west).
0.05-	54.4	PARK east of the abandoned SR tracks. DO NOT BLOCK THE ROAD OR DRIVEWAYS. The Pennsylvanian bedrock exposure lies along the railroad cut on the south side of the tunnel. USE EXTREME CAUTION in getting from your car to the rock exposure.

STOP 5. View a sandstone and shale sequence near the southern tunnel portal of the abandoned SR at the southern edge of Tunnel Hill (E l/2 NE SE Sec. 35, T11S, R3E, 3rd P.M., Johnson County, Creal Springs 7.5-minute Quadrangle [37088E7]). The sequence contains trace fossils.


T U N N E L   H I L L
TO 5
Webbtown Ch
Webb Cem
Chapman Cem
Anderson
Beaver
Creek
Cave
Cem
BM 795
1 mi
1½ km
0
½
1


Tunnel Hill
Tunnel Hill Sch
Sandburn
NEW YORK
CENTRAL
PIPELINE
Cache
Creek
Choate Cem
Albright Cem
Webb Cem
25
26
27
34
35
36
5
0
½
1 mi
0
½
1
1½ km

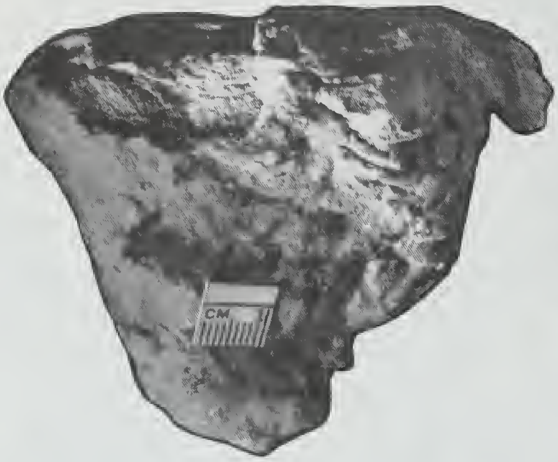
Stratigraphy and Lithology

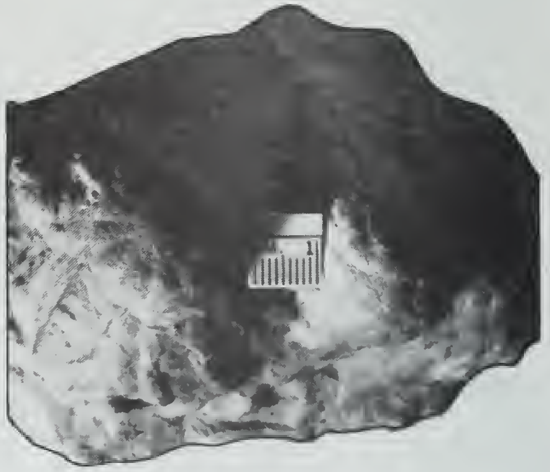
A dark gray, silty shale grades upward from the base of the railroad cut into a medium to light gray, shaly siltstone. Evidence of *bioturbation* increases upward as does the grain size. At the top is a thinly bedded, very fine-grained sandstone that has shaly interbeds; it is about 10 feet thick and contains abundant ichnofossils. Another dark gray shale lies above the sandstone unit; it is thinly laminated and contains siderite nodules. The second shale unit is about 15 feet thick and part of another coarsening-upward sequence. Above the second shale is a light gray, very fine-grained shaly quartz sandstone that contains numerous ichnofossils and shale clasts. It grades upward into a medium gray, fine-grained, nonshaly, clean quartz sandstone.

Ichnofossils

Trace fossils found in the lower siltstone-sandstone facies are *Conostichus broadheadi*, *C. stouti*, *Asterosoma* sp., *Teichichnus* sp., *Sclarituba missouriensis* and *Rhizocorallium* sp. (figs. 20 to 25). Trace fossils found in the upper shaly silty sandstone facies are *Conostichus*, *Asterosoma*, *Eiona* sp. (fig. 26), *Cylindrichnus* sp. (fig. 27), and *Sclarituba missouriansis.*

The ichnofossils *Conostichus* and *Asterosoma*, made by burrowing sea anemones (Chamberlin 1971, Devera 1989), and *Rhizocorallium*, probably produced by a polycheate





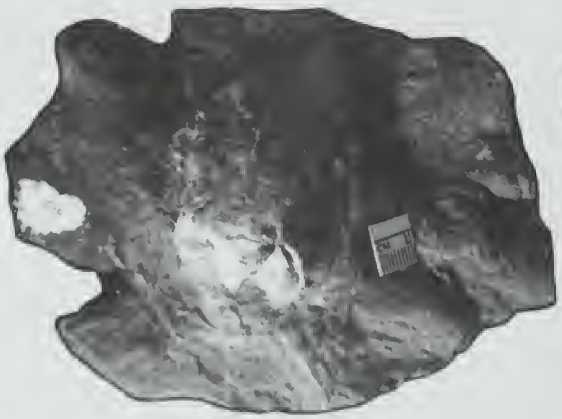


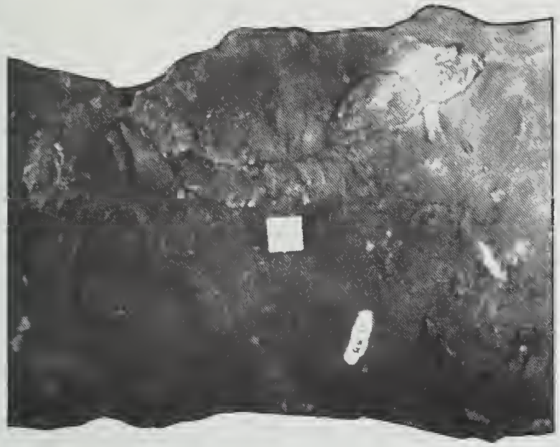
Figure 20 *(upper left) Conostichus broadhedi.* **Figure 21** *(upper right) Conostichus stouti.*
Figure 22 *(lower left) Asterosoma* sp. **Figure 23** *(lower right) Teichichus* sp.

worm, indicate marine conditions during deposition. The most likely environment of deposition was an open bay or a shallow shelf sand body near a *distributary* mouth bar. These types of environments commonly develop upward-coarsening cycles.

Interpretation of the Pennsylvanian Environment

The coarsening-upward sequences, with grain size increasing upward, represent infilling of a localized basin or bay and indicate that sediments were deposited in

- progressively shallower water,
- a progressively higher energy environment,
- a standing body of water (ocean, lake, or pond) rather than in a flowing stream.



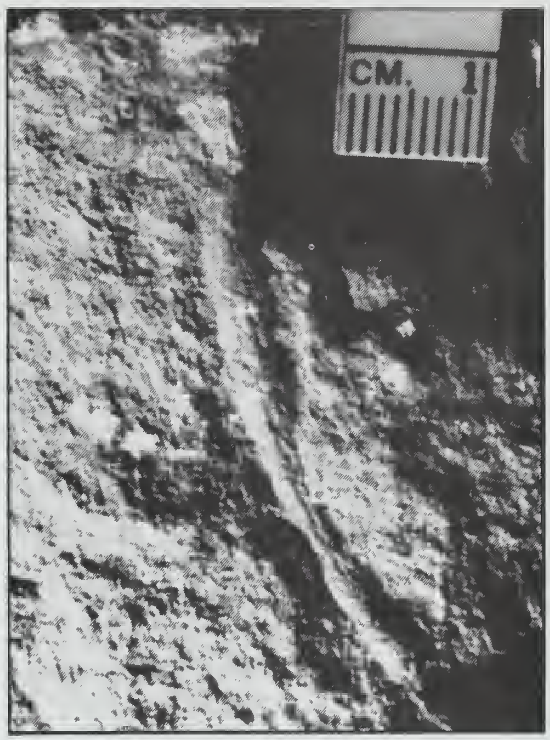
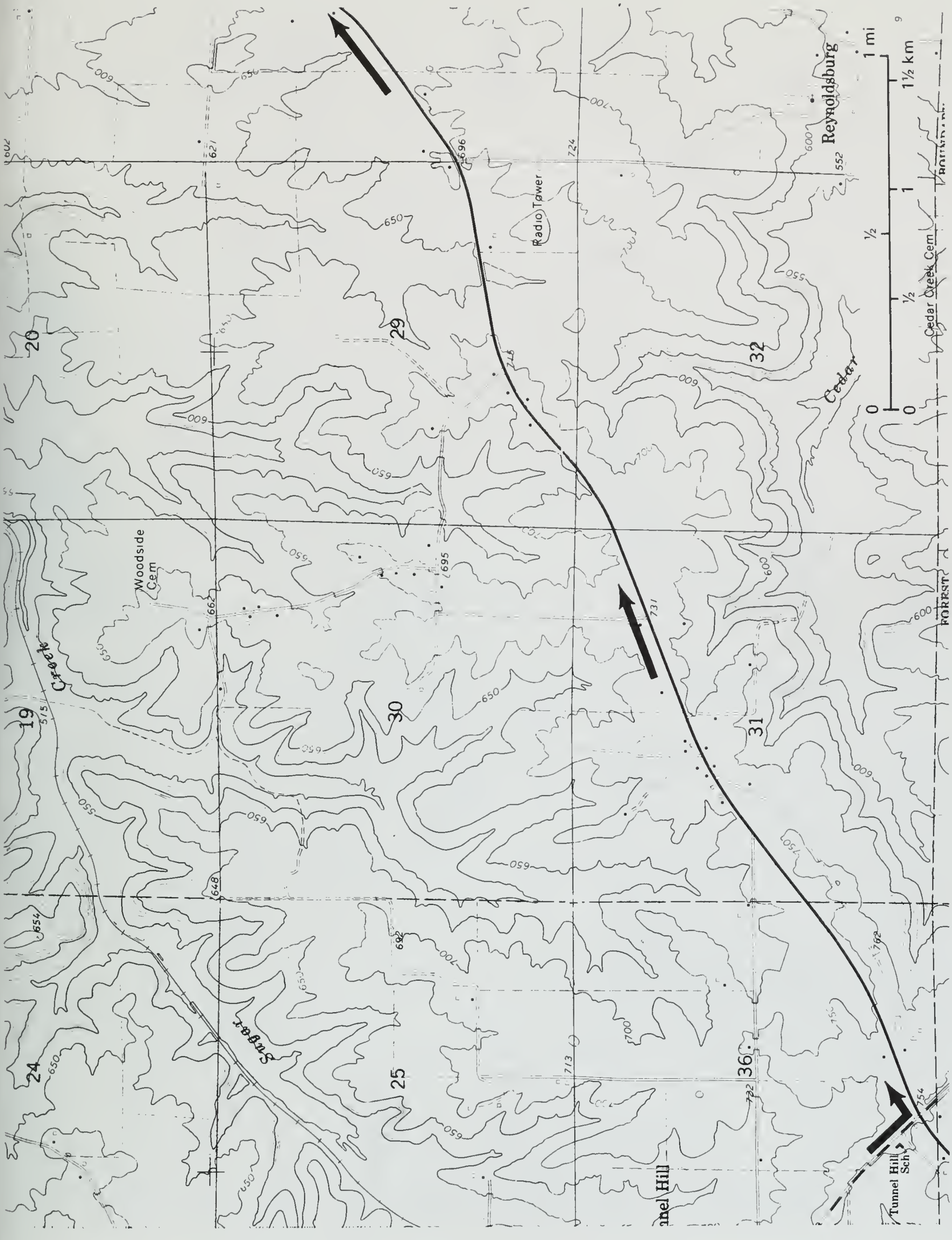


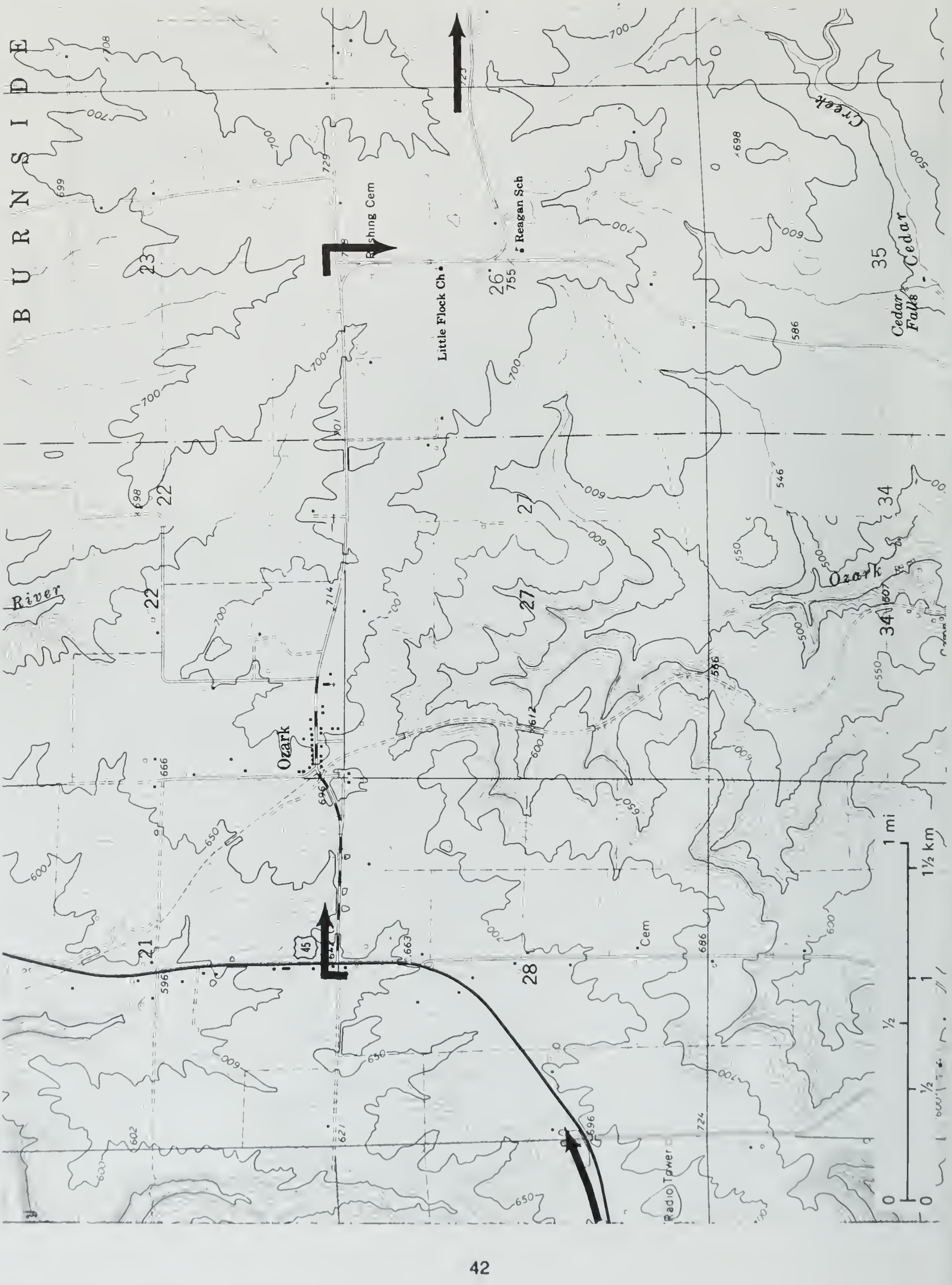
Figure 24 *(upper left) Sclarituba missouriensis.* **Figure 25** *(upper right) Rhizocorallium* sp.
Figure 26 *(lower left) Eiona* sp. **Figure 27** *(lower right) Cylindrichus* sp.

The upward increase in the amount of bioturbation indicates that the rate of deposition was gradually decreasing, allowing burrowing organisms more time to churn through the sediments. Increased bioturbation also could mean a higher influx of organic material from land and thus larger numbers of burrowing organisms in these environments.

Traces of sea anemones and *polycheate worms*, increased biologic activity upward, and increased grain size upsection, all reaffirm an interpretation of a nearshore marine environment like that of an open bay.

0.0	54.4	Leave Stop 5. CONTINUE AHEAD (west) across the railroad tracks.
0.05-	54.4+	STOP: 1-way. TURN LEFT (south) on black top at 1580N/1090E.
0.3+	54.7+	Cross over SR tunnel.
0.5+	55.25+	New Simpson Hill School CD 32 is located to our right.
0.1	55.35+	STOP: 2-way at (1505N/1140E) with US 45. TURN LEFT (northeast) on US 45.
2.4+	57.75+	Historical monument to the left reads: "Old Ft. Massac and Kaskaskia Trail crossed this county at this point."
1.35+	59.15+	Prepare to turn right.
0.1+	59.25+	TURN RIGHT on Ozark Road at T-road intersection (1700N/1450E).
0.5+	59.8	Camp Ondessonk entrance is to the right.
0.05-	59.8+	CAUTION: enter village of Ozark. CONTINUE AHEAD (east).
3.45+	63.3+	Blacktop ends. Enter Pope County.
0.5+	63.8+	CAUTION: Y-intersection of 3130N/050E (Pope County). BEAR LEFT (northeast) around Zion Church and cemetery (follow Bell Smith Springs signs).
0.1+	63.95	Cross over Illinois Central Railroad (ICRR) tunnel (at position of the pole line with cross arms). At slightly more than 1.3 miles (7,000+ feet), this is the longest railroad tunnel in Illinois. To the northeast, the route traverses the divide between the Saline River drainage to the left (north and northeast) and the Bay Creek drainage to the right (south and southeast). The drainage divide is largely controlled by the McCormick *Anticline*, a northeast-southwest-trending bedrock structure. The Bay Creek *Syncline* lies about 1.75 miles to the south and southeast, roughly paralleling the McCormick Anticline.
1.55+	65.5+	Y-intersection at Olive Church: BEAR RIGHT (northeast) toward Burden Falls and Bell Smith Springs. (Note the sign: 2 miles to Burden Falls.)
0.55+	66.1	Y-intersection at hamlet of McCormick: BEAR RIGHT (northeast) toward Burden Falls and Bell Smith Springs and cross the crest of the McCormick Anticline. (Note this sign: 2 miles to Burden Falls.)


Reynoldsburg
Radio Tower
Woodside Cem
Sugar
Creek
Cedar
Cedar Creek Cem
Tunnel Hill Sch
Tunnel Hill
19
20
24
25
29
30
31
32
36
0 ½ 1 mi
0 ½ 1 1½ km



BURNSIDE
River
Ozark
Little Flock Ch
Reagan Sch
Cem
Radio Tower
Creek
Cedar
Cedar Falls
Ozark
1 mi
1½ km


URNSIDE
NATIONAL
Abbot Hollow
Hill
Zion Hill Ch
Zion Ch
Old Zion Cem
BM
Reagan Sch
Rushing Cem
ILLINOIS
Creek
19
20
23
24
25
29
30
31
35
36
0
½
1
1 mi
1½ km

1.6+	67.7+	CAUTION: T-road intersection. TURN LEFT (northeast, leaving Bell the Smith Springs route) toward Burden Falls and SR 145.
0.4+	68.15+	PARK in small open area to the left or along roadside.

STOP 6. View and discuss Burden Falls (SW SE SW NE Sec. 15, T11S, R5E, 3rd P.M., Pope County, Stonefort 7.5-minute Quadrangle [37088E6]). Hike the trail along the Pennsylvanian Caseyville Formation exposures and the falls.

Burden Falls, like Ferne Clyffe, is composed of the Caseyville Formation. Look for primary sedimentary structures like crossbedding and ripple marks. Is the Caseyville from Burden Falls different from Ferne Clyffe? Does the *lithology* differ? Is the Pennsylvanian environment the same at Burden Falls as it was at Ferne Clyffe?

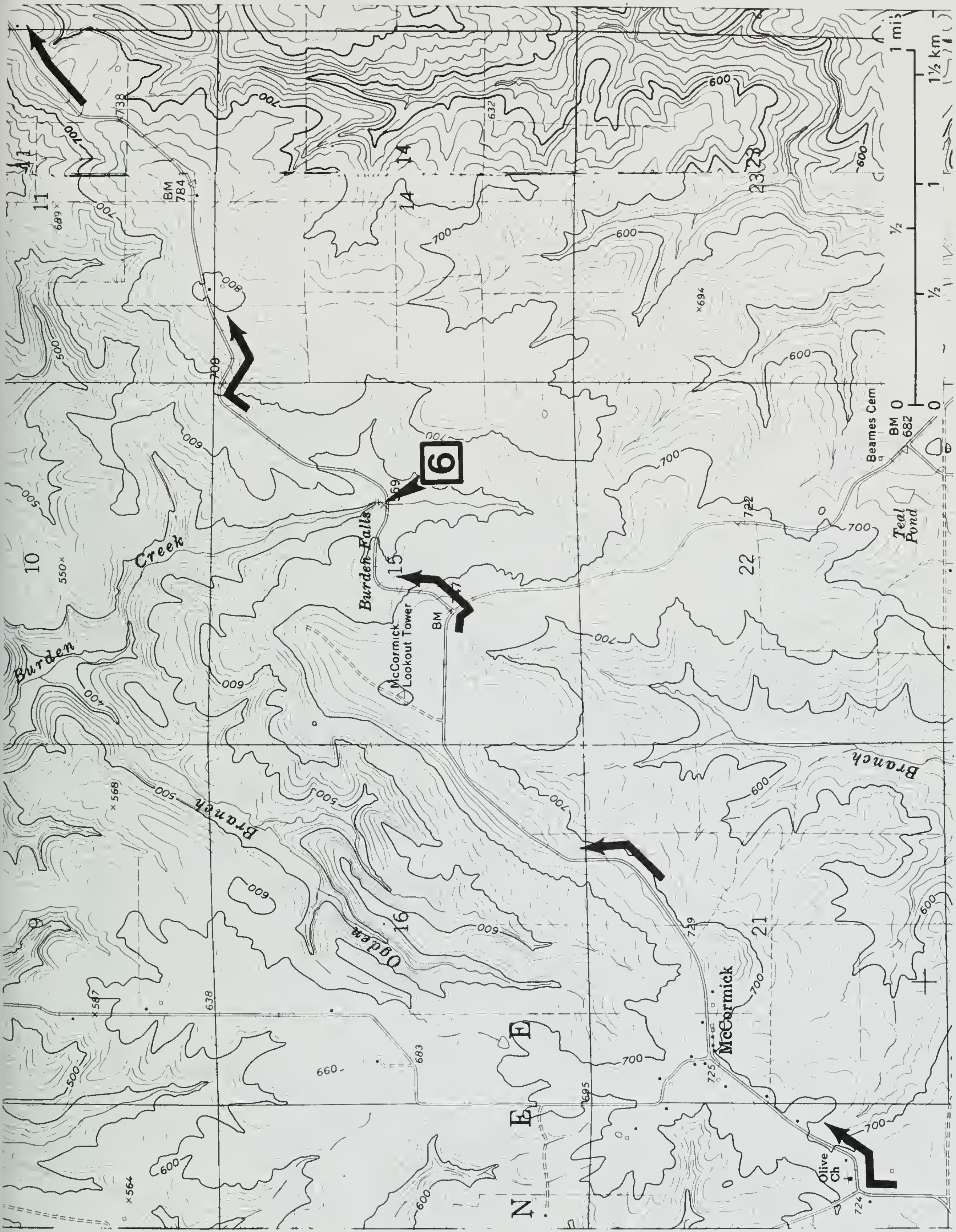
0.0	68.15+	Leave Stop 6 and CONTINUE AHEAD (east) over Burden Creek ford.
2.7+	70.9+	TURN LEFT (north) at T-road intersection, 3460N/575E.
0.35+	71.25+	Cross crest of McCormick Anticline.
0.9+	72.2+	T-road intersects from right. TURN RIGHT (north).
0.15+	72.4+	Enter Saline County.
0.2	72.6+	Cross axis of Battle Ford Syncline.
0.7	73.3+	T-road intersects from left. TURN LEFT (west). CAUTION: road ahead is rough.
0.55	73.85+	Cross *fault* associated with the New Burnside Anticline.
0.4	74.25+	PARK along the roadside without blocking the road.

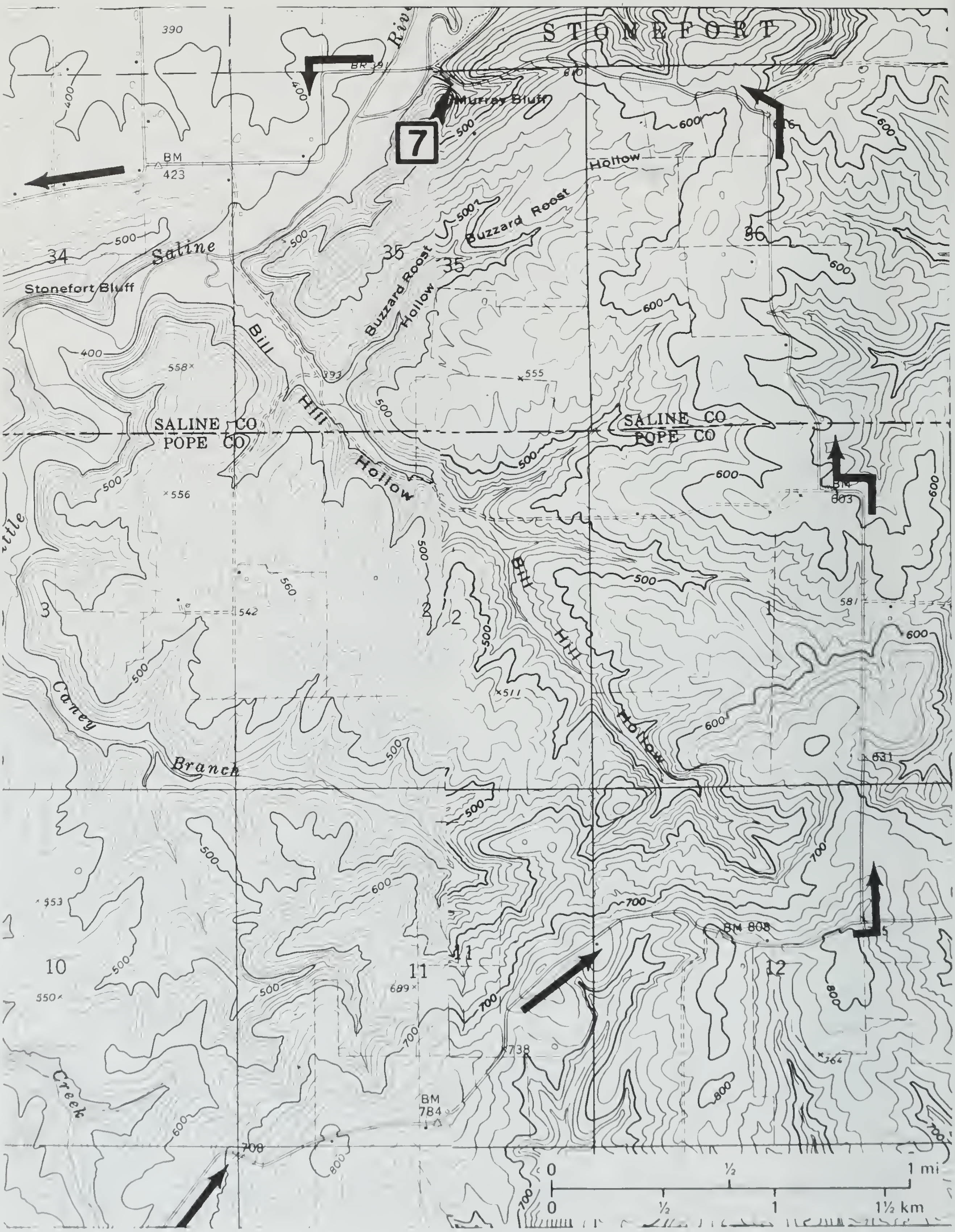
STOP 7. View and study exposures of the Murray Bluff Sandstone, the uppermost member of the Pennsylvanian Abbott Formation located in southwestern Saline County (southern parts of Secs. 25 and 26 and the northern parts of Secs. 35 and 36, T10S, R5E, 3rd P.M., Eddyville 7.5-minute Quadrangle [37088E5]). Note the iron-oxide banding (Liesegang) and laminated, thick-bedded sandstone.

Lithology and Distribution

The Murray Bluff Sandstone Member, a broadly lenticular sandstone, reaches about 120 feet in thickness near the area of Murray Bluff (*type section*). It is primarily composed of coarse-grained, *sublitharenites*. Locally, some of the sandstone *facies* are quite clean, well-sorted, fine- to medium-grained quartz arenites. Although Liesegang banding is a common feature of Abbott sandstones, this type of banding is not restricted to the Abbott. The iron-oxide rings are produced by postdepositional groundwater and not directly related to the characteristics of the sediments during deposition.

The Murray Bluff Sandstone forms a thick-bedded, laminated, prominent bluff with tabular and trough crossbeds. Abbott sandstones are usually dirtier than underlying Caseyville


Burden Creek
Burden Falls
McCormick Lookout Tower
McCormick
Ogden Branch
Branch
Teal Pond
Beames Cem
Olive Ch
6
1 mi
1½ km


STONEFORT
Murray Bluff
7
BM 423
Saline
Stonefort Bluff
Buzzard Roost Hollow
Buzzard Roost
Hollow
Bill Hill Hollow
SALINE CO
POPE CO
Caney Branch
Creek
BM 808
BM 784
0 ½ 1 mi
0 ½ 1 1½ km

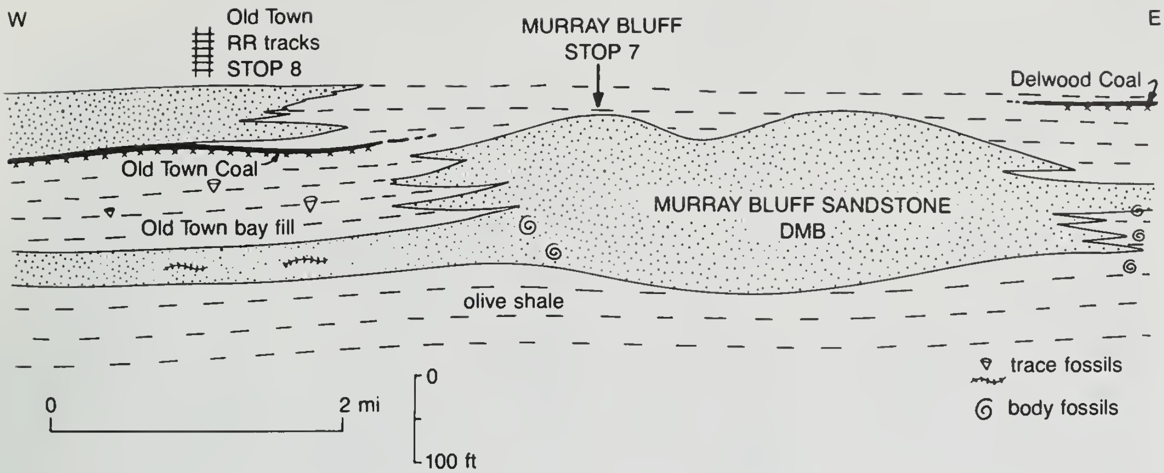


Figure 28 Schematic cross section of upper Abbott outcrop showing horizontally equivalent facies between Stops 7 and 8.

sandstones (Kosanke et al, 1960) and commonly contain quartz granules, clay, feldspar, and mica flakes. East and west from the type area, the Murray Bluff Sandstone tapers like a lens. About 4 miles to the west, south of Old Town, it interfingers with a shale; the top 60 feet is replaced by a silty, sandy, shale.

Interpretation of the Pennsylvanian Environment

The geometry, sedimentology, and lithology of the Murray Bluff indicate that it is a *distributary* mouth bar, common to deltaic environments. Horizontally equivalent facies also support the deltaic interpretation. The shales on the sides of the Murray Bluff are composed of deltaic turbidites (mudstones and siltstones) and other bay fill facies (fig. 28).

0.0	74.25+	Leave Stop 7 and CONTINUE AHEAD (north).
0.05	74.3+	T-road intersection. TURN LEFT (west).
0.15	74.45+	Cross Little Saline River.
0.9+	75.35+	T-road intersection. TURN LEFT (south) and then curve right (west).
1.25+	76.65+	T-road intersects from right. CONTINUE AHEAD (west).
1.15+	77.8+	T-road intersects from right. CONTINUE AHEAD (west).
0.3+	78.15+	T-road intersects from left. CONTINUE AHEAD (west). This is the hamlet of Old Town.
0.15	78.3+	PARK along road shoulder before you get to the two unguarded ICRR tracks. ***The railroad is private property and this is a dangerous location. Stand BACK from the tracks and watch for trains.*** View the railroad cut with binoculars.

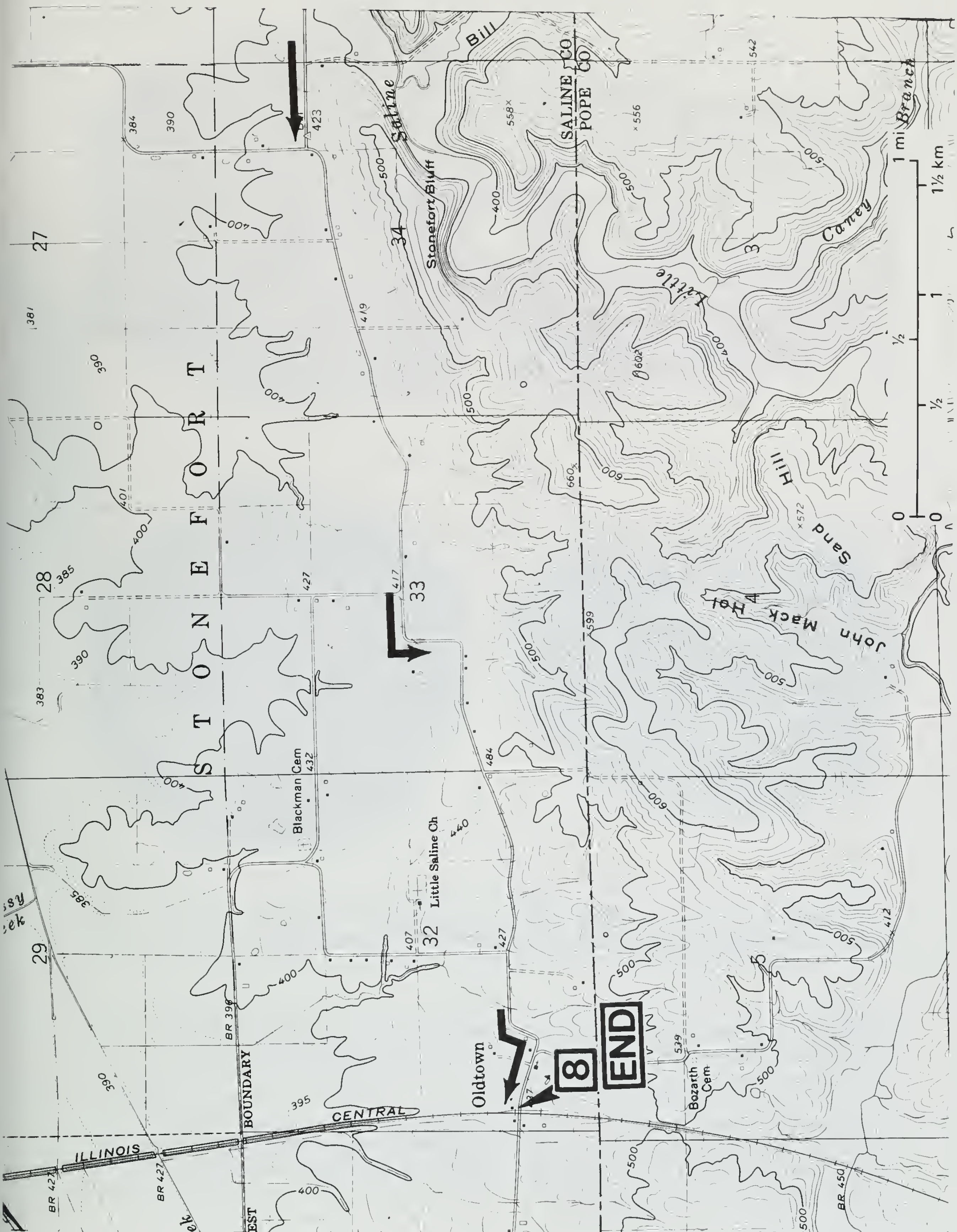
Figure 29 Mudstone and siltstones of the upper Abbott Formation; interpreted to be "Sea Anemone Bay" filled in.

STOP 8. In Old Town, we will stop just before two unguarded railroad tracks (NE NW SW SW Sec. 32, T10S, R5E, 3rd P.M., Saline County, Stonefort 7.5-minute Quadrangle [37088E6]) to view a 60-foot, manmade cut of shaly rocks near the Abbott/Spoon contact about 0.4 mile south of Old Town (SW NW NW Sec. 5, T11S, R5E, 3rd P.M., Pope County, Stonefort 7.5-minute Quadrangle [37088E6]). Note the difference in rock types, as we discussed at Stop 7 and will discuss here at Stop 8.

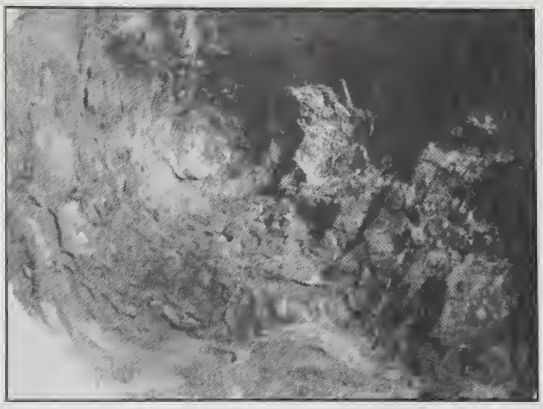
Stratigraphy, Lithology, and Distribution of a Thick Shale Sequence

The lower part of this section is a fine- to medium-grained, thin-bedded quartz sandstone that belongs to the lower portion of the Murray Bluff Sandstone Member. It is light gray with yellow and orange iron-oxide stains. Siderite nodules, shale clasts, and black shale partings occur in this sandstone. Also, you can see faint ripple marks and lens-shaped beds.

Horizontally equivalent to the upper part of the Murray Bluff Sandstone is the 60-foot, thick, silty shale unit that makes up the major part of this exposure (fig. 29). The shale conformably overlies the thin-bedded part of the lower Murray Bluff. This shale is dark gray and becomes an interbedded, sandy shale at the top. In turn, the shale unit is covered by an underclay with plant-root structures and a bright-banded coal about 2 feet thick.



S T O N E F O R T
SALINE CO
POPE CO
Saline
Stonefort Bluff
Bill
Little Saline Ch
Blackman Cem
Oldtown
Bozarth Cem
BOUNDARY
ILLINOIS
CENTRAL
Little
Caney
Branch
Sand
Hill
John Mack Hol
8
END
27
28
29
32
33
34
3
4
5
0
½
1 mi
0
½
1
1½ km



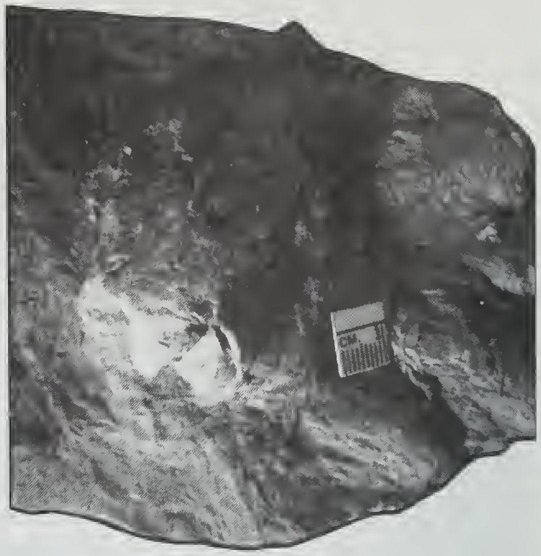
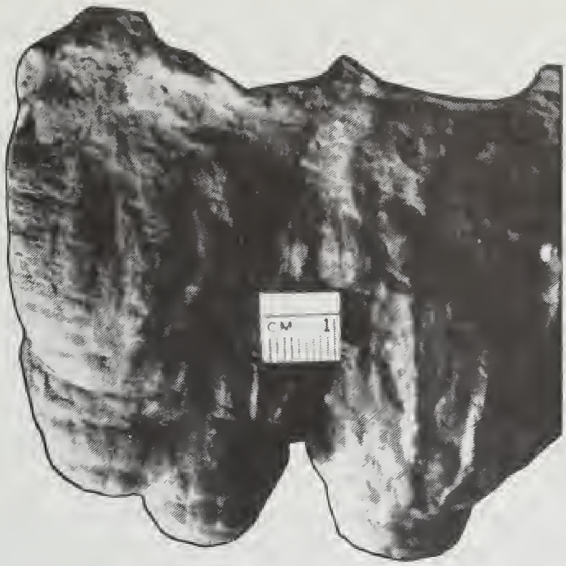


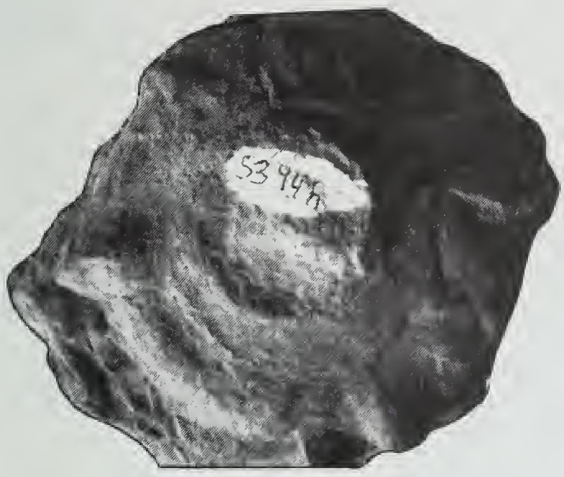
Figure 30 *(upper left)* *Conostichus* sp. **Figure 31** *(upper right)* *Asterosoma* sp.
Figure 32 *(lower left)* *Teichichnus* sp. **Figure 33** *(lower right)* *Gyrolithes* sp.

Ichnology

The 60-foot thick, silty shale sequence has a low-density, low-diversity ichnofauna dominated by cone-shaped trace fossils of *Conostichus* (fig. 30). *Asterosoma*, *Teichichnus*, and *Gyrolithes* are also present (figs. 31 to 33).

Conostichus usually has a special, small disc at the base of the cone that can show duodecimal (12-fold) symmetry. It also has well-developed longitudinal furrows. *C. stouti* and *C. broadheadi* are also found here. The symmetry, cone-like shape and basal disc with longitudinal furrows are strikingly similar to traces left today by burrowing actinarian sea anemones (Chamberlin 1971) (fig. 34).





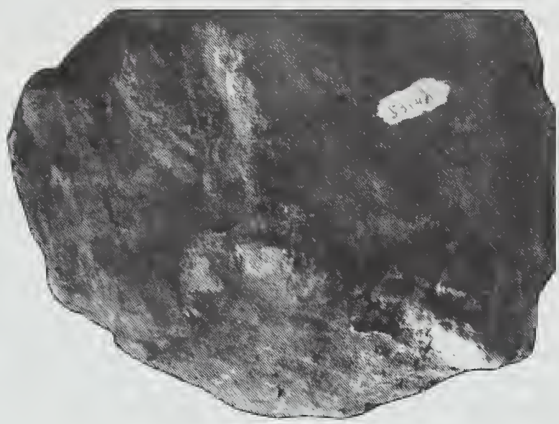


Figure 34 *(upper)* *Conostichus stouti* with 12-fold symmetry. Cone shape and basal discs have longitudinal furrows. **Figure 35** *(lower left)* Photo shows morphology and activities of both *Conostichus* and *Asterosoma*. **Figure 36** *(lower right)* *Conostichus* and *Asterosoma* component.

Asterosoma sp. has elongate, bulbous radiating arms that connect at a central plug (fig. 35). In the Illinois Basin, wherever one finds *Conostichus* one also finds *Asterosoma* associated with it (Devera 1989). Chamberlin (1971) noted that *Asterosoma* is typically associated with *Conostichus* in the Pennsylvanian of the Ouachita region. Specimens found at the Old Town locality show characteristics of both *Conostichus* and *Asterosoma* within the same specimen (Devera 1989). Instead of the annelid (worm) affinity proposed by Chamberlin (1971) for *Asterosoma*, I think *Asterosoma* represents only a different type of burrowing behavior of an actinarian sea anemone (fig.36).

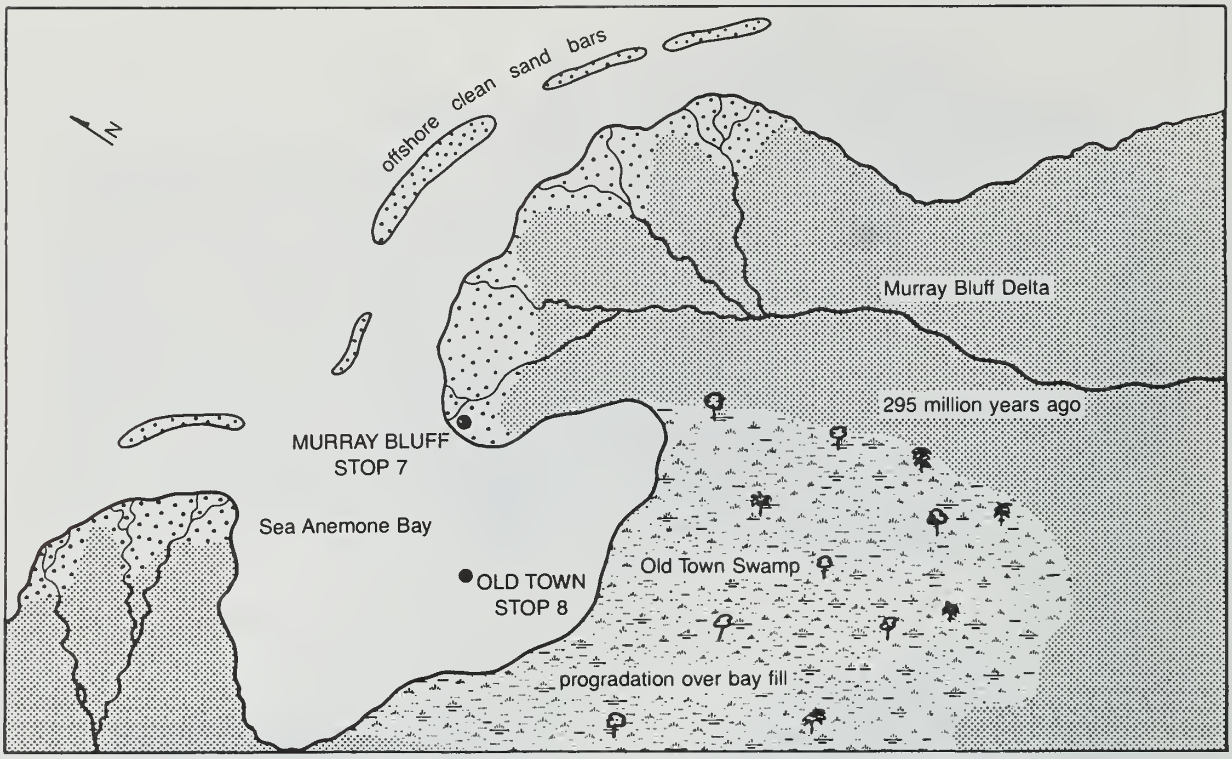


Figure 37 Paleogeography during late Abbott deposition for area near Stops 7 and 8.

Interpretation of the Pennsylvanian Environment at Old Town

The origin of the silty shale at Old Town is interpreted as a marine-influenced interdistributary bay that was subsequently filled and turned into a paralic swamp that, in turn, was eventually filled by a laterally migrating or *prograding* delta. Support for the marine interpretation of the rocks comes from the trace fossil assemblage. The rooted underclay and coal found on top of the shale is evidence for the swamp. The sandstone above the coal is probably another migrating distributary from the large delta in the area (fig. 37).

End of Ferne Clyffe geological science field trip.

To leave the last stop and head for home safely, follow these directions: CONTINUE AHEAD (west-northwest) for 1.1 miles to t-road intersection. TURN RIGHT (north) for 0.55 miles to US 45 in village of Stonefort. TURN RIGHT (northeast) on US 45 toward Harrisburg (13 miles) and routes SRs 34, 145 and 13. TURN LEFT (southwest) on US 45 toward New Burnside (4 miles) and SR 166 north to Marion and I-57. CONTINUE AHEAD (southwest) beyond New Burnside on US 45 to Vienna and I-24.

Join us on the next geological science field trip.

REFERENCES

Archer, A. W., Devera, J. A., Kvale, E., and W. J. Nelson, 1989, Tidally influenced deposits of Early Pennsylvanian age, *in* Carboniferous Geology of the Eastern United States: 28th International Geological Congress, Field Trip Guidebook T-143, p. 30.

Bell, A. H., M. O. Oros, and J. Van Den Berg, 1961, Petroleum industry in Illinois, 1960: Part I, Oil and gas developments: Illinois State Geological Survey, Champaign, Illinois Petroleum 75, 121 p.

Bonnell, C., 1946, The Illinois Ozarks: privately published, 156 p.

Chamberlin, C. K., 1971, Morphology an ethology of trace fossils from the Ouachita Mountains, southeast Oklahoma: Journal of Paleontology, v. 45, p. 212-246.

Cote, W. E., D. L. Reinertsen, and G. M. Wilson, 1966, Vienna area: Illinois State Geological Survey, Champaign, Geological Science Field Trip Guide Leaflet 1966-A, 18 p.

Devera, J. A., 1986, Trace fossils in the Abbott and Caseyville Formations of the Eddyville Quadrangle, southern Illinois (abstract): Geological Society of America, Abstracts with Programs, v. 18, no. 4, p. 286.

Devera, J. A. Mason, C. E., and Peppers, R. A., 1987, A marine shale in the Caseyville Formation (Lower Pennsylvanian) in southern Illinois (abstract): Geological Society of America, Abstracts with Programs, p. 220.

Devera, J. A., 1989, Ichnofossil assemblages and associated lithofacies of the Lower Pennsylvanian (Caseyville and Tradewater Formations), southern Illinois, *in* Geology of the Lower Pennsylvanian in Kentucky, Indiana and Illinois: Illinois Basin Consortium, v. 1.

Evers, R. A., and L. M. Page, 1977, Some unusual natural areas in Illinois: Illinois Natural History Survey, Champaign, Biological Notes 100, 47 p.

Gary, M., R. McAfee, Jr., and C. L. Wolf (editors), 1972, Glossary of Geology: American Geological Institute, Washington, D.C., 857 p.

Griffith, K., and W. Griffith, 1943, Spotlight on Egypt: Guidebook of the Scenic and Historic places in Egypt, Illinois: Egypt Book House, Carbondale, Illinois, 24 p.

Haney, S. D., 1976, Shawnee Forest Guide to Southeastern Illinois, Featuring Gallatin, Hardin, Pope and Saline Counties: Martin Printing and Album Co., Flora, Illinois, 120 p.

Harris, D. L., 1981, Tides and tidal datums in the U.S.: U.S. Army Corps of Engineers Coastal Engineering Research Center, Special Report 7.

Harris, S. E., Jr., C. W. Horrell, and D. Irwin, 1977, Exploring the Land and Rocks of Southern Illinois: A Geological Guide: Southern Illinois University Press, Carbondale and Edwardsville, Illinois, 240 p.

Horberg, L., 1950, Bedrock topography of Illinois: Illinois State Geological Survey, Champaign, Bulletin 73, 111 p.

Kosanke, R. M., J. A. Simon, H. R. Wanless, and H. B. Willman, 1960, Classification of the Pennsylvanian strata of Illinois: Illinois State Geological Survey, Champaign, Report of Investigation 214, 84 p.

Kvale, E. P., and D. M. Ullin, 1988, Tidal influence in an Upper Caseyville deltaic sequence, southern Illinois: Geological Society of America, Abstracts with Programs, v. 20, no. 5.

Leighton, M. M., G. E. Ekblaw, and L. Horberg, 1948, Physiographic Divisions of Illinois: Illinois State Geological Survey, Champaign, Report of Investigations 129, 19 p.

Piskin, K., and R. E. Bergstrom, 1975, Glacial drift in Illinois: Thickness and character: Illinois State Geological Survey, Champaign, Circular 490, 35 p.

Pryor, W. A., 1956, Groundwater geology in southern Illinois: A preliminary geologic report: Illinois State Geological Survey, Champaign, Circular 212, 25 p.

Reinertsen, D. L., 1978, A guide to the geology of the Marion area—Williamson, Union, and Johnson Counties, Illinois: Illinois State Geological Survey, Champaign, Geological Science Field Trip Guide Leaflet 1978-D, 20 p.

Reinertsen, D. L., R. J. Jacobson, J. A. Devera, and W. J. Nelson, 1987, Tunnel Hill area—Johnson and Pope Counties: Illinois State Geological Survey, Champaign, Geological Science Field Trip Guide Leaflet 1987A, 49 p.

Samson, I. E., 1989, Illinois mineral industry in 1987 and review of preliminary mineral production data for 1988: Illinois State Geological Survey, Champaign, Illinois Mineral Notes 101, 43 p.

Treworgy, J. D., 1981, Structural features in Illinois: A compendium: llinois State Geological Survey, Champaign, Circular 519, 22 p.

Voigt, J. W., and R. H. Mohlenbrock, 1956, An Ozark Odyssey: Southern Illinois University Printing Service, Carbondale, 13 p.

Willman, H. B., E. A. Atherton, T. C. Buschbach, C. W. Collinson, J. C. Frye, M. E. Hopkins, J. A. Lineback, and J. A. Simon, 1975, Handbook of Illinois stratigraphy: Illinois State Geological Survey, Champaign, Bulletin 95, 261 p.

Willman, H.B., and J.C. Frye, 1980, The glacial boundary in southern Illinois: Illinois State Geological Survey, Champaign, Circular 511, 23 p.

GLOSSARY

Anticline: convex-upward rock fold; core contains older rocks than does the perimeter of the structue.

Arenite: (1) consolidated sedimentary rocks composed of sand-sized fragments regardless of composition; (2) a nearly pure sandstone containing less than 10 percent argillaceous matrix; (3) a selectively and slowly deposited sediment well-washed by currents.

Argillaceous: largely composed of clay-sized partcles or clay minerals.

Bioturbation: disruption of sediments by biota, especially churning and stirring of a sediment by organisms.

Climbing ripple: one of a series of cross laminae produced by superimposed migrating ripples, in which the crests of vertically succeeding laminae appear to be advancing upslope.

Cuesta: asymmetric hill or ridge with a long, gentle (back or dip) slope, conforming with the resistant bed(s) that form it, on one side and a steep (scarp) slope or cliff on the other, formed by the outcrop of the resistant bed(s).

Delta: low, nearly flat, alluvial land deposited at or near the mouth of a river; commonly a triangular or fan-shaped plain sometimes extending beyond the general trend of the coastline.

Desiccation crack: crack in sediment produced by drying (e.g., a mud crack).

Distributary: irregular, divergent stream flowing away from the main stream and not returning to it, as in a delta.

Estuary: seaward end or the widened funnel-shaped tidal mouth of a river valley...where tidal effects are evident.

Facies: (1) sum of all lithologic and paleontologic characteristics exhibited by a sedimentary rock; (2) exclusive, mappable, and areally restricted part of a defined stratigraphic rock body; (3) term applied to intertonguing sedimentary rock masses of differing lithologic and paleontologic characteristics, occurring within a stratigraphic unit, having irregular boundaries.

Fault: surface or zone of rock fracture along which there has been vertical and/or horizontal displacement.

Flaser structure: consists of fine sand or silt lenticles that are commonly aligned.

Flute: discontinuous, scooped depression about 1 to 3 inches long, formed by scouring action of a turbulent, sediment-laden current of water flowing over a muddy bottom; it has a steep or abrupt upcurrent end where the depth of the mark is the greatest; its long axis generally parallels the direction of current.

Litharenite: sandstone, regardless of texture, containing more than 25 percent fine-grained rock fragments, less than 10 percent of the feldspar minerals, and less than 75 percent quartz, quartzite, and chert.

Lithology: description of rocks on the basis of color, structures, mineral composition, and grain size; the physical character of a rock.

Neap tide: tide with an unusually small or reduced tide range (usually 10 to 30 percent less than the mean range).

Physiographic province (or division): (1) a region, all parts of which are similar in geologic structure and climate, and consequently, which has had a unified geologic history; (2) a region whose pattern of relief features or landforms differs significantly from that of adjacent regions.

Polycheate worms: class of annelid (segmented) marine worms common to seacoasts where some live in U-shaped tubes in beach sands; its chitinous jaws may be preserved in many systems of rocks from ?Precambrian to Recent.

Prograding (shoreline): shoreline that is being built forward or outward into a sea or lake by deposition and accumulation of sediments.

Spring tide: (1) tide of greater-than-average range twice each month, during new and full moons; (2) strong or heavy flow.

Stratigraphy: study, definition, and description of major and minor natural divisions of rocks, especially the study of the form, arrangement, geographic distribution, chronologic succession, classification, correlation, and mutual relationships of rock strata.

Stratigraphic unit: stratum or body of strata recognized as a unit in the classification of the rocks of the Earth's crust with respect to any specific rock character, property, or attribute or for any purpose such as description, mapping, and correlation.

Sublitharenite: sandstone that does not have enough rock fragments to be classed as a litharenite (5 to 25 percent fine-grained rock fragments, 65 to 95 percent quartz, quartzite, and chert, and less than 10 percent feldspar).

Syncline: concave-upward rock fold; the core contains younger rocks than does the perimeter of the structure.

Tectonic: pertaining to the global forces involved in, or the resulting structures or features of Earth's movements.

Tectonics: the branch of geology dealing with the broad architecture of the upper (outer) part of the Earth's crust; a regional assembling of structural or deformational features, their origins, historical evolution, and mutual relations.

Type section: original sequence of strata as described for a given locality or area; an objective standard for comparison purposes; preferably shows maximum thickness and is completely exposed, or at least shows the top and the bottom contacts. There is only *one* type section.

PLEISTOCENE GLACIATIONS IN ILLINOIS

Origin of the Glaciers

During the past million years or so, an interval of time called the Pleistocene Epoch, most of the northern hemisphere above the 50th parallel has been repeatedly covered by glacial ice. The cooling of the earth's surface, a prerequisite for glaciation, began at least 2 million years ago. On the basis of evidence found in subpolar oceans of the world (temperature-dependent fossils and oxygen-isotope ratios), a recent proposal has been made to recognize the beginning of the Pleistocene at 1.6 million years ago. Ice sheets formed in sub-arctic regions many times and spread outward until they covered the northern parts of Europe and North America. In North America, early studies of the glacial deposits led to the model that four glaciations could explain the observed distribution of glacial deposits. The deposits of a glaciation were separated from each other by the evidence of intervals of time during which soils formed on the land surface. In order of occurrence from the oldest to the youngest, they were given the names Nebraskan, Kansan, Illinoian, and Wisconsinan Stages of the Pleistocene Epoch. Work in the last 30 years has shown that there were more than four glaciations but the actual number and correlations at this time are not known. Estimates that are gaining credibility suggest that there may have been about 14 glaciations in the last one million years. In Illinois, estimates range from 4 to 8 based on buried soils and glacial deposits. For practical purposes, the previous four glacial stage model is functional, but we now know that the older stages are complex and probably contain more than one glaciation. Until we know more, all of the older glacial deposits, including the Nebraskan and Kansan will be classified as pre-Illinoian. The limits and times of the ice movement in Illinois are illustrated in the following pages by several figures.

The North American ice sheets developed when the mean annual temperature was perhaps 4° to 7°C (7° to 13°F) cooler than it is now and winter snows did not completely melt during the summers. Because the time of cooler conditions lasted tens of thousands of years, thick masses of snow and ice accumulated to form glaciers. As the ice thickened, the great weight of the ice and snow caused them to flow outward at their margins, often for hundreds of miles. As the ice sheets expanded, the areas in which snow accumulated probably also increased in extent.

Tongues of ice, called lobes, flowed southward from the Canadian centers near Hudson Bay and converged in the central lowland between the Appalachian and Rocky Mountains. There the glaciers made their farthest advances to the south. The sketch below shows several centers of flow, the general directions of flow from the centers, and the southern extent of glaciation. Because Illinois lies entirely in the central lowland, it has been invaded by glaciers from every center.

Effects of Glaciation

Pleistocene glaciers and the waters melting from them changed the landscapes they covered. The glaciers scraped and smeared the landforms they overrode, leveling and filling many of the minor valleys and even some of the larger ones. Moving ice carried colossal amounts of rock and earth, for much of what the glaciers wore off the ground was kneaded into the moving ice and carried along, often for hundreds of miles.

The continual floods released by melting ice entrenched new drainageways, deepened old ones, and then partly refilled both with sediments as great quantities of rock and earth were carried beyond the glacier fronts. According to some estimates, the amount of water drawn from the sea and changed into ice during a glaciation was enough to lower the sea level from 300 to 400 feet below present level. Consequently, the melting of a continental ice sheet provided a tremendous volume of water that eroded and transported sediments.

In most of Illinois, then, glacial and meltwater deposits buried the old rock-ribbed, low, hill-and-valley terrain and created the flatter landforms of our prairies. The mantle of soil material and the buried deposits of gravel, sand, and clay left by the glaciers over about 90 percent of the state have been of incalculable value to Illinois residents.

Glacial Deposits

The deposits of earth and rock materials moved by a glacier and deposited in the area once covered by the glacier are collectively called **drift**. Drift that is ice-laid is called **till**. Water-laid drift is called **outwash**.

Till is deposited when a glacier melts and the rock material it carries is dropped. Because this sediment is not moved much by water, a till is unsorted, containing particles of different sizes and compositions. It is also stratified (unlayered). A till may contain materials ranging in size from microscopic clay particles to large boulders. Most tills in Illinois are pebbly clays with only a few boulders. For descriptive purposes, a mixture of clay, silt, sand and boulders is called **diamicton**. This is a term used to describe a deposit that could be interpreted as till or a mass wasting product.

Tills may be deposited as **end moraines**, the arc-shaped ridges that pile up along the glacier edges where the flowing ice is melting as fast as it moves forward. Till also may be deposited as **ground moraines**, or **till plains**, which are gently undulating sheets deposited when the ice front melts back, or retreats. Deposits of till identify areas once covered by glaciers. Northeastern Illinois has many alternating ridges and plains, which are the succession of end moraines and till plains deposited by the Wisconsinan glacier.

Sorted and stratified sediment deposited by water melting from the glacier is called **outwash**. Outwash is bedded, or layered, because the flow of water that deposited it varied in gradient, volume, velocity, and direction. As a meltwater stream washes the rock materials along, it sorts them by size—the fine sands, silts, and clays are carried farther downstream than the coarser gravels and cobbles. Typical Pleistocene outwash in Illinois is in multilayered beds of clays, silts, sands, and gravels that look much like modern stream deposits in some places. In general, outwash tends to be coarser and less weathered, and alluvium is most often finer than medium sand and contains variable amounts of weathered material.

Outwash deposits are found not only in the area covered by the ice field but sometimes far beyond it. Meltwater streams ran off the top of the glacier, in crevices in the ice, and under the ice. In some places, the cobble-gravel-sand filling of the bed of a stream that flowed in the ice is preserved as a sinuous ridge called an **esker**. Some eskers in Illinois are made up of sandy to silty deposits and contain mass wasted diamicton material. Cone-shaped mounds of coarse outwash, called **kames**, were formed where meltwater plunged through crevasses in the ice or into ponds on the glacier.

The finest outwash sediments, the clays and silts, formed bedded deposits in the ponds and lakes that filled glacier-dammed stream valleys, the sags of the till plains, and some low, moraine-diked till plains. Meltwater streams that entered a lake rapidly lost speed and also quickly dropped the sands and gravels they carried, forming deltas at the edge of the lake. Very fine sand and silts were commonly redistributed on the lake bottom by wind-generated currents, and the clays, which stayed in suspension longest, slowly settled out and accumulated with them.

Along the ice front, meltwater ran off in innumerable shifting and short-lived streams that laid down a broad, flat blanket of outwash that formed an **outwash plain**. Outwash was also carried away from the glacier in valleys cut by floods of meltwater. The Mississiippi, Illinois, and Ohio Rivers occupy valleys that were major channels for meltwaters and were greatly widened and deepened during times of the greatest meltwater floods. When the floods waned, these valleys were partly filled with outwash far beyond the ice margins. Such outwash deposits, largely sand and gravel, are known as **valley trains**. Valley train deposits may be both extensive and thick. For instance, the long valley train of the Mississippi Valley is locally as much as 200 feet thick.

Loess, Eolian Sand and Soils

One of the most widespread sediments resulting from glaciation was carried not by ice or water but by wind. **Loess** is the name given to windblown deposits dominated by silt. Most of the silt was derived from wind erosion of the valley trains. Wind action also sorted out **eolian sand** which commonly formed **sand dunes** on the valley trains or on the adjacent uplands. In places, sand dunes have migrated up to 10 miles away from the principle source of sand. Flat areas between dunes are generally underlain by eolian **sheet sand** that is commonly reworked by water action. On uplands along the major valley trains, loess and eolian sand are commonly interbedded. With increasing distance from the valleys, the eolian sand pinches out, often within one mile.

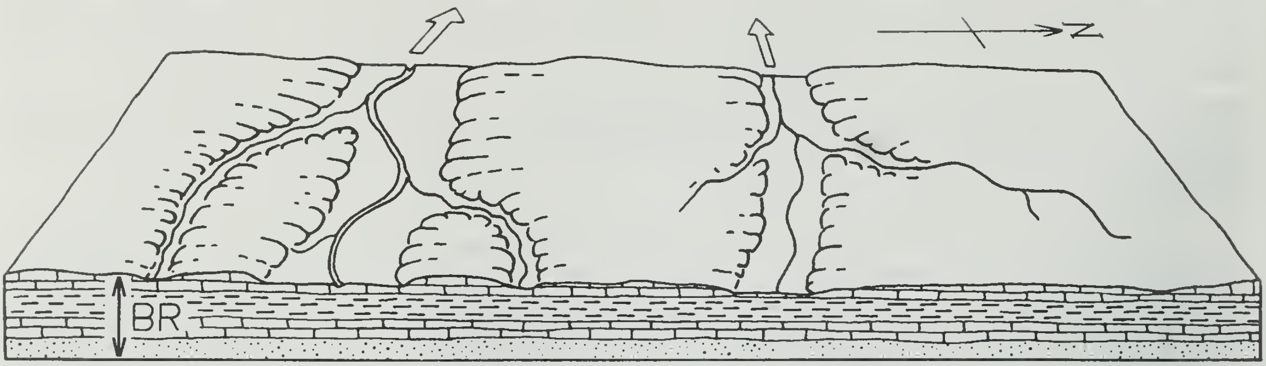
Eolian deposition occurred when certain climatic conditions were met, probably in a seasonal pattern. Deposition could have occurred in the fall, winter or spring season when low precipitation rates and low temperatures caused meltwater floods to abate, exposing the surfaces of the valley trains and permitting them to dry out. During Pleistocene time, as now, west winds prevailed, and the loess deposits are thickest on the east sides of the source valleys. The loess thins rapidly away from the valleys but extends over almost all the state.

Each Pleistocene glaciation was followed by an interglacial stage that began when the climate warmed enough to melt the glaciers and their snowfields. During these warmer intervals, when the climate was similar to that of today, drift and loess surfaces were exposed to weather and the activities of living things. Consequently, over most of the glaciated terrain, soils developed on the Pleistocene deposits and altered their composition, color, and texture. Such soils were generally destroyed by later glacial advances, but some were buried. Those that survive serve as “key beds,” or stratigraphic markers, and are evidence of the passage of a long interval of time.

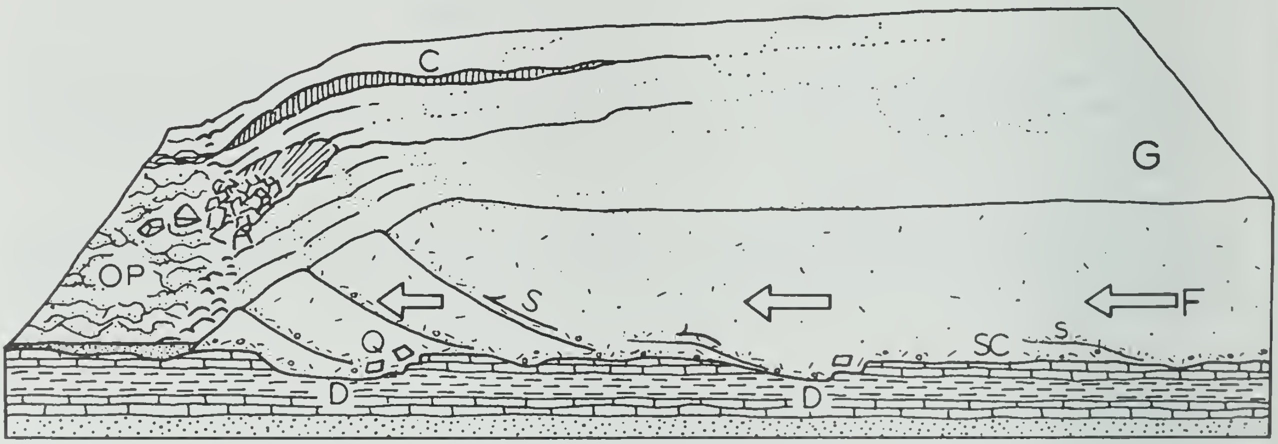
Glaciation in a Small Illinois Region

The following diagrams show how a continental ice sheet might have looked at various stages as it moved across a small region in Illinois. They illustrate how it could change the old terrain and create a landscape like the one we live on. To visualize how these glaciers looked, geologists study the landforms and materials left in the glaciated regions and also the present-day mountain glaciers and polar ice caps.

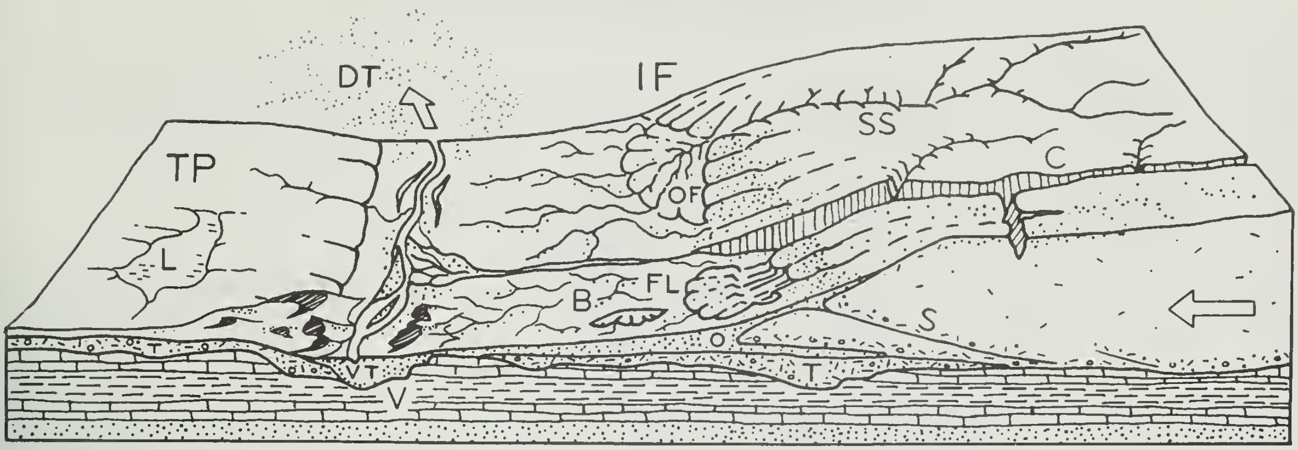
The block of land in the diagrams is several miles wide and about 10 miles long. The vertical scale is exaggerated—layers of material are drawn thicker and landforms higher than they ought to be so that they can be easily seen.



1. **The Region Before Glaciation** — Like most of Illinois, the region illustrated is underlain by almost flat-lying beds of sedimentary rocks—layers of sandstone ( ), limestone ( ), and shale ( ). Millions of years of erosion have planed down the bedrock (BR), creating a terrain of low uplands and shallow valleys. A residual soil weathered from local rock debris covers the area but is too thin to be shown in the drawing. The streams illustrated here flow westward and the one on the right flows into the other at a point beyond the diagram.



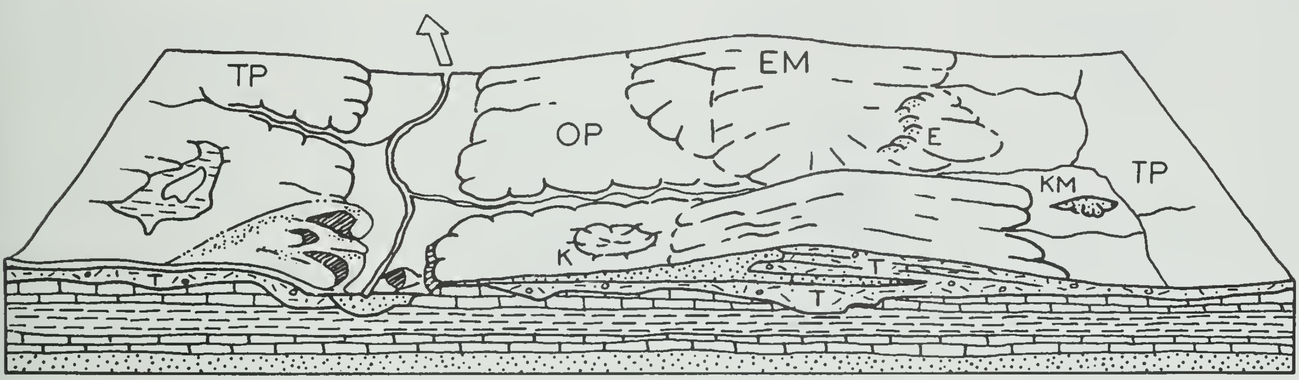
2. **The Glacier Advances Southward** — As the Glacier (G) spreads out from its ice snowfield accumulation center, it scours (SC) the soil and rock surface and quarries (Q)—pushes and plucks up—chunks of bedrock. The materials are mixed into the ice and make up the glacier's "load." Where roughnesses in the terrain slow or stop flow (F), the ice "current" slides up over the blocked ice on innumerable shear planes (S). Shearing mixes the load very thoroughly. As the glacier spreads, long cracks called "crevasses" (C) open parallel to the direction of ice flow. The glacier melts as it flows forward, and its meltwater erodes the terrain in front of the ice, deepening (D) some old valleys before ice covers them. Meltwater washes away some of the load freed by melting and deposits it on the outwash plain (OP). The advancing glacier overrides its outwash and in places scours much of it up again. The glacier may be 5000 or so feet thick, and tapers to the margin, which was probably in the range of several hundred feet above the old terrain. The ice front advances perhaps as much as a third of a mile per year.



3. **The Glacier Deposits an End Moraine** — After the glacier advances across the area, the climate warms and the ice begins to melt as fast as it advances. The ice front (IF) is now stationary, or fluctuating in a narrow area, and the glacier is depositing an end moraine.

As the top of the glacier melts, some of the sediment that is mixed in the ice accumulates on top of the glacier. Some is carried by meltwater onto the sloping ice front (IF) and out onto the plain beyond. Some of the debris slips down the ice front in a mudflow (FL). Meltwater runs through the ice in a crevasse (C). A supraglacial stream (SS) drains the top of the ice, forming an outwash fan (OF). Moving ice has overridden an immobile part of the front on a shear plane (S). All but the top of a block of ice (B) is buried by outwash (O).

Sediment from the melted ice of the previous advance (figure 2) remains as a till layer (T), part of which forms the till plain (TP). A shallow, marshy lake (L) fills a low place in the plain. Although largely filled with drift, the valley (V) remains a low spot in the terrain. As soon as the ice cover melts, meltwater drains down the valley, cutting it deeper. Later, outwash partly refills the valley: the outwash deposit is called a valley train (VT). Wind blows dust (DT) off the dry floodplain. The dust will form a loess deposit when it settles. Sand dunes (D) form on the south and east sides of streams.



4. **The Region after Glaciation** — As the climate warms further, the whole ice sheet melts, and glaciation ends. The end moraine (EM) is a low, broad ridge between the outwash plain (OP) and till plains (TP). Run-off from rains cuts stream valleys into its slopes. A stream goes through the end moraine along the channel cut by the meltwater that ran out of the crevasse in the glacier.

Slopewash and vegetation are filling the shallow lake. The collapse of outwash into the cavity left by the ice block's melting has made a kettle (K). The outwash that filled a tunnel draining under the glacier is preserved in an esker (E). The hill of outwash left where meltwater dumped sand and gravel into a crevasse or other depression in the glacier or at its edge is a kame (KM). A few feet of loess covers the entire area but cannot be shown at this scale.

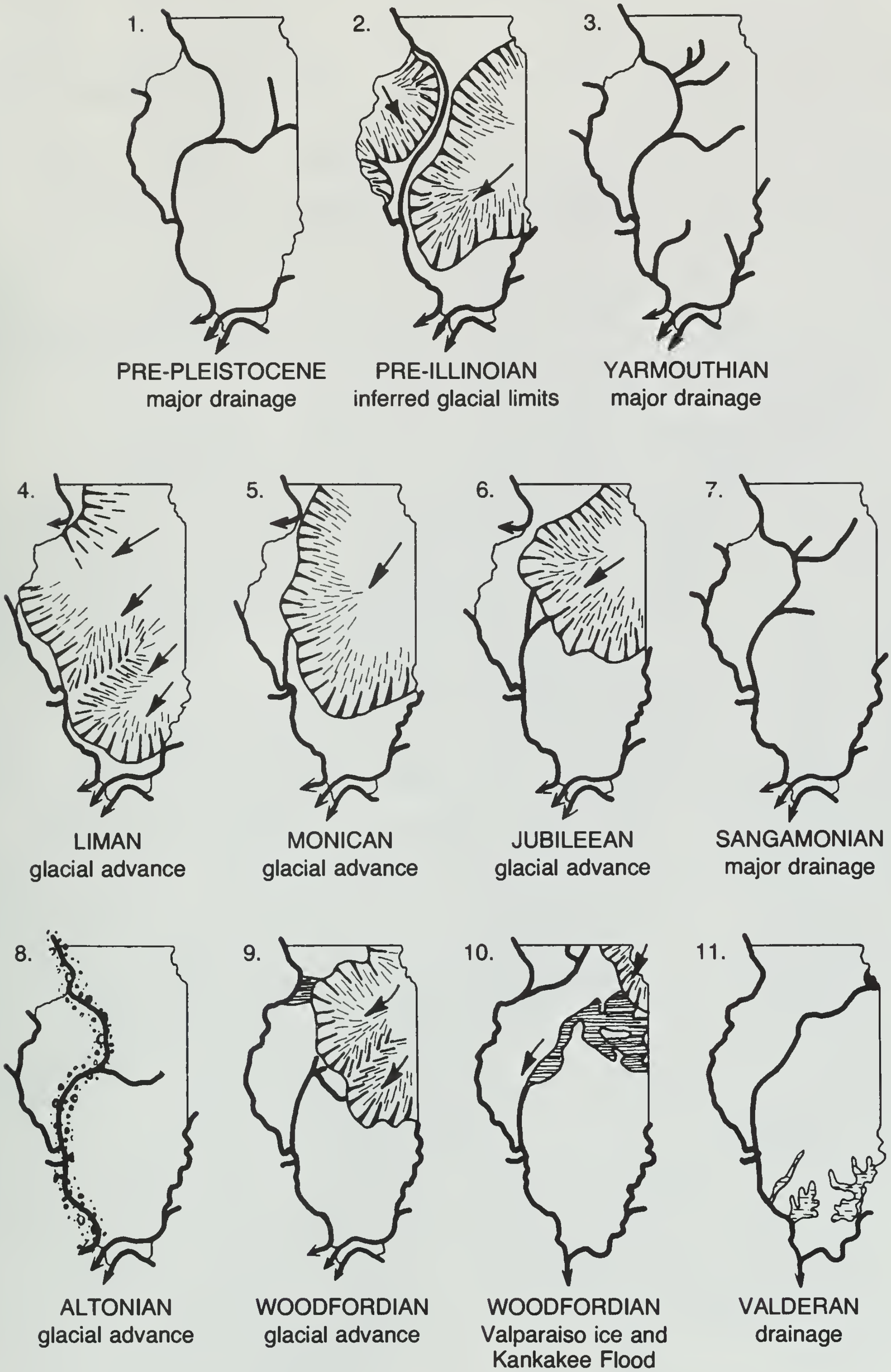
TIME TABLE OF PLEISTOCENE GLACIATION

		STAGE		SUBSTAGE	NATURE OF DEPOSITS	SPECIAL FEATURES
QUATERNARY		HOLOCENE (interglacial)		Years Before Present	Soil, youthful profile of weathering, lake and river deposits, dunes, peat	
				10,000		
	Pleistocene	WISCONSINAN (glacial)	late	Valderan	Outwash, lake deposits	Outwash along Mississippi Valley
				11,000		
				Twocreekan	Peat and alluvium	Ice withdrawal, erosion
				12,500		
				Woodfordian	Drift, loess, dunes, lake deposits	Glaciation; building of many moraines as far south as Shelbyville; extensive valley trains, outwash plains, and lakes
				25,000		
			mid	Farmdalian	Soil, silt, and peat	Ice withdrawal, weathering, and erosion
				28,000		
			early	Altonian	Drift, loess	Glaciation in Great Lakes area, valley trains along major rivers
				75,000		
		SANGAMONIAN (interglacial)			Soil, mature profile of weathering	Important stratigraphic marker
				125,000		
		ILLINOIAN (glacial)		Jubileean	Drift, loess, outwash	Glaciers from northeast at maximum reached Mississippi River and nearly to southern tip of Illinois
				Monican	Drift, loess, outwash	
				Liman	Drift, loess, outwash	
				300,000?		
		YARMOUTHIAN (interglacial)			Soil, mature profile of weathering	Important stratigraphic marker
				500,000?		
	Pre-Illinoian	KANSAN* (glacial)			Drift, loess	Glaciers from northeast and northwest covered much of state
				700,000?		
		AFTONIAN* (interglacial)			Soil, mature profile of weathering	(hypothetical)
				900,000?		
		NEBRASKAN* (glacial)			Drift (little known)	Glaciers from northwest invaded western Illinois
				1,600,000 or more		

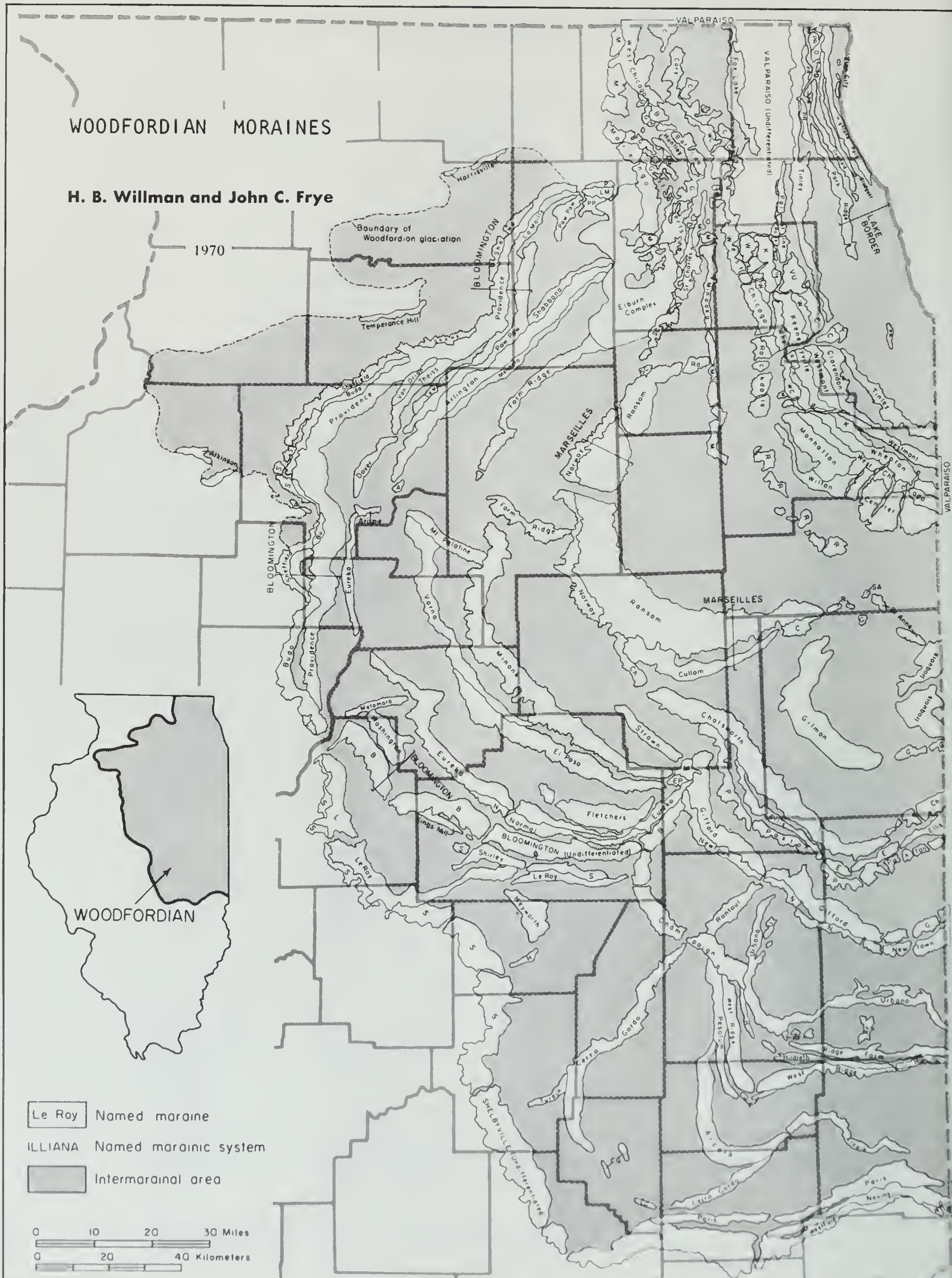
*Old oversimplified concepts, now known to represent a series of glacial cycles.

(Illinois State Geological Survey, 197

SEQUENCE OF GLACIATIONS AND INTERGLACIAL DRAINAGE IN ILLINOIS



(Modified from Willlman and Frye, "Pleistocene Stratigraphy of Illinois," ISGS Bull. 94, fig. 5, 1970.)


WOODFORDIAN MORAINES
H. B. Willman and John C. Frye
1970
Boundary of Woodfordian glaciation
VALPARAISO
VALPARAISO (Undifferentiated)
LAKE BORDER
BLOOMINGTON
MARSEILLES
ILLIANA
SHELBYVILLE
SHELBYVILLE Undifferentiated
BLOOMINGTON (Undifferentiated)
Harrisville
Temperance Hill
Atkinson
Sheffield
Buda
Providence
Shabbona
Paw Paw
La Moille
Arlington
Mendota
Farm Ridge
Dover
Arispie
Mt Palatine
Eureka
Varna
Minonk
Metamora
Washington
Normal
Kings Mill
Shirley
Le Roy
Heyworth
El Paso
Fletchers
Gifford
Newtown
Cullom
Ransom
Norway
Streator
Chatsworth
Gilman
Iroquois
Elburn Complex
Fox Lake
West Chicago
Huntley
St. Charles
Minooka
Rockdale
Chicago
Keeneyville
Clarendon
Westmont
Manhattan
Wheaton
Wilton
Tinley
Park Ridge
Rantoul
Champaign
Urbana
Pesotum
West Ridge
Hildreth
Cerro Gordo
Tuscola
Arcola
Paris
Nevins
Westfield
Le Roy
Named moraine
ILLIANA
Named morainic system
Intermorainal area
WOODFORDIAN
0 10 20 30 Miles
0 20 40 Kilometers

ILLINOIS STATE GEOLOGICAL SURVEY

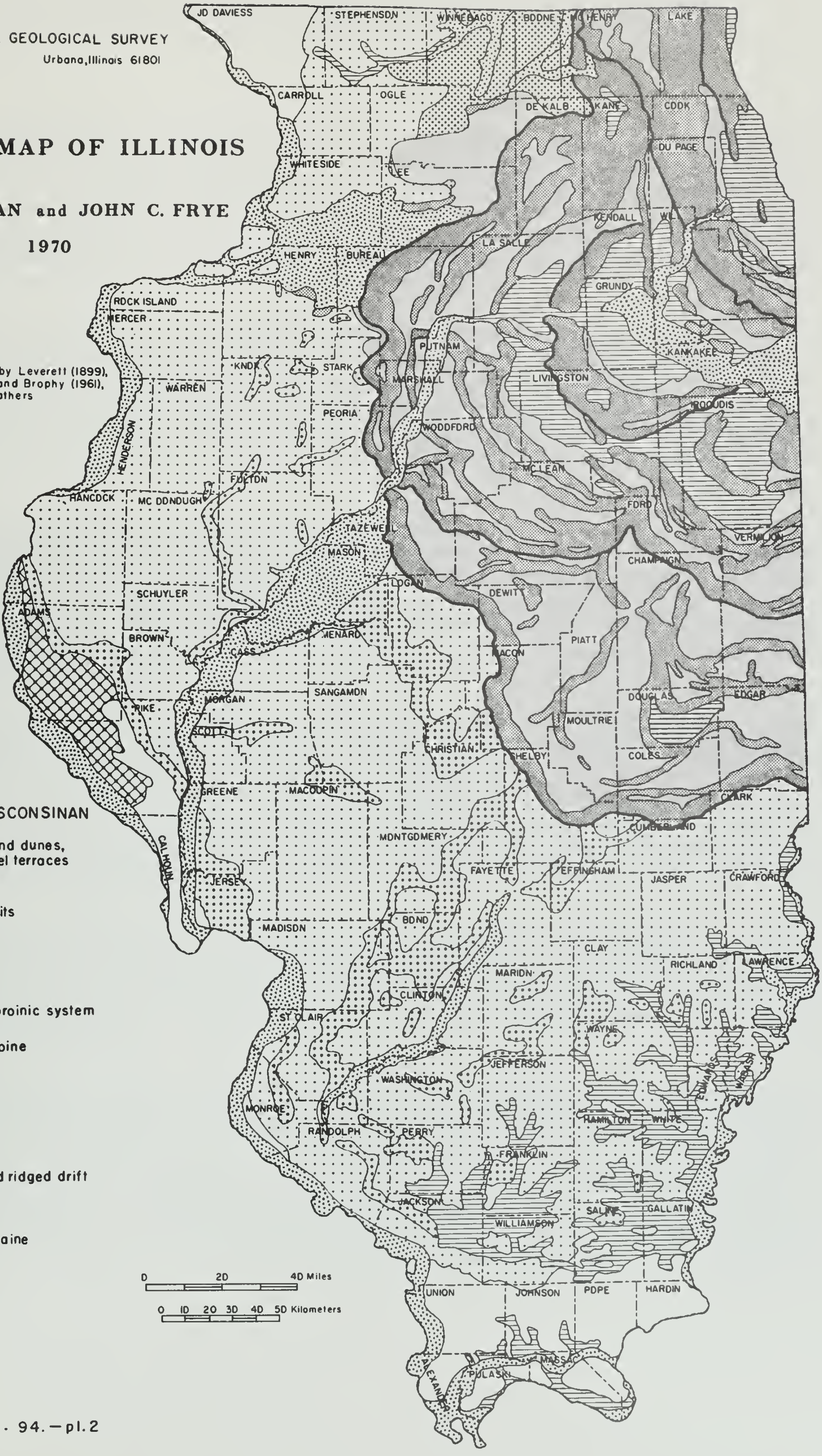
John C. Frye, Chief Urbana, Illinois 61801

GLACIAL MAP OF ILLINOIS

H.B. WILLMAN and JOHN C. FRYE

1970

Modified from maps by Leverett (1899), Ekblow (1959), Leighton and Brophy (1961), Willman et al. (1967), and others



EXPLANATION

HOLOCENE AND WISCONSINAN

Alluvium, sand dunes, and gravel terraces

WISCONSINAN

Lake deposits

WOODFORDIAN

Moraine

Front of morainic system

Groundmoraine

ALTONIAN

Till plain

ILLINOIAN

Moraine and ridged drift

Groundmoraine

KANSAN

Till plain

DRIFTLESS

Modified from Bull. 94.—pl. 2

DEPOSITIONAL HISTORY OF THE PENNSYLVANIAN ROCKS IN ILLINOIS

At the close of the Mississippian Period, about 310 million years ago, the sea withdrew from the Midcontinent region. A long interval of erosion that took place early in Pennsylvanian time removed hundreds of feet of the pre-Pennsylvanian strata, completely stripping them away and cutting into older rocks over large areas of the Midwest. Ancient river systems cut deep channels into the bedrock surface. Later, but still during early Pennsylvanian (Morrowan) time, the sea level started to rise; the corresponding rise in the base level of deposition interrupted the erosion and led to filling the valleys in the erosion surface with fluvial, brackish, and marine sands and muds.

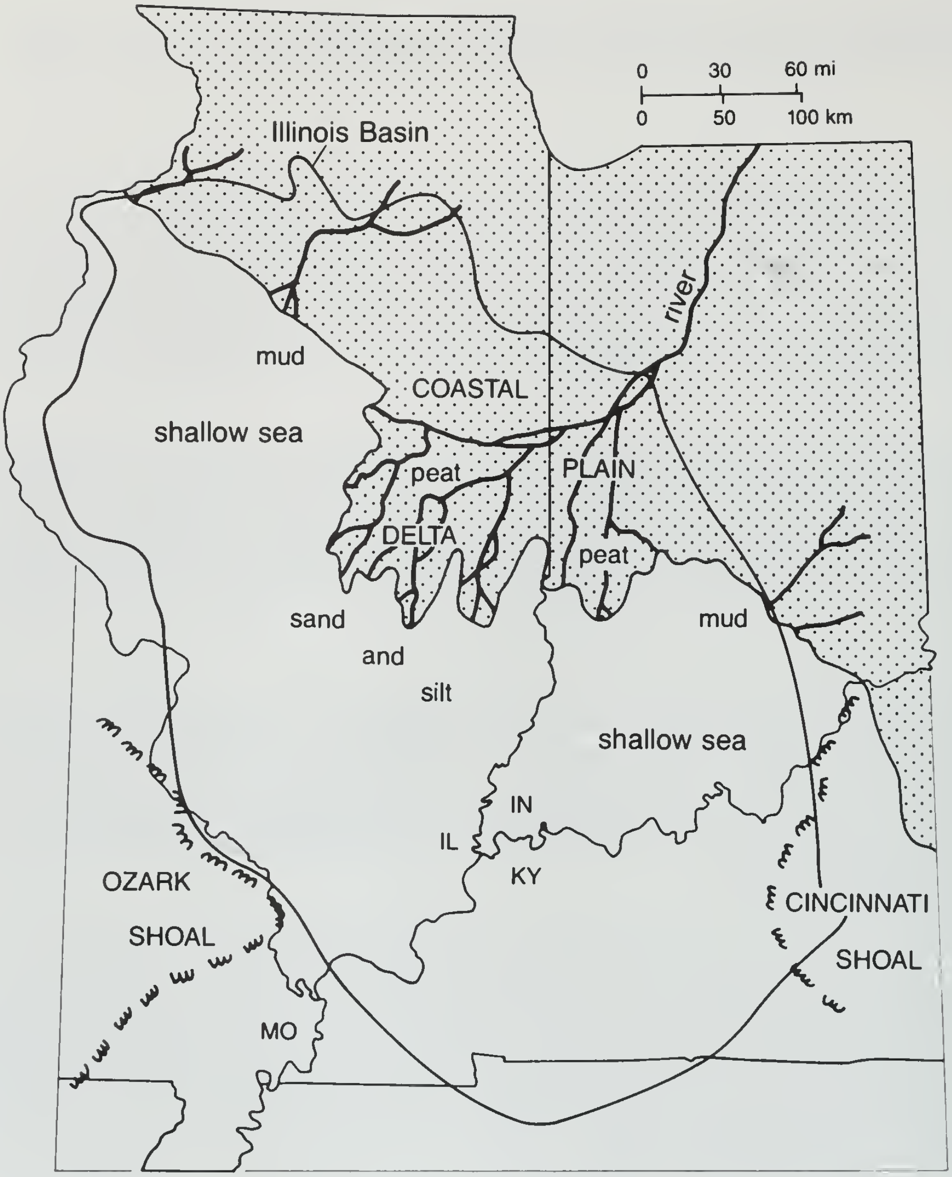
Depositional conditions in the Illinois Basin during the Pennsylvanian Period were somewhat similar to those of the preceding Chesterian (late Mississippian) time. A river system flowed southwestward across a swampy lowland, carrying mud and sand from highlands to the northeast. This river system formed thin but widespread deltas that coalesced into a vast coastal plain or lowland that prograded (built out) into the shallow sea that covered much of present-day Illinois (see paleogeographic map, next page). As the lowland stood only a few feet above sea level, slight changes in relative sea level caused great shifts in the position of the shoreline.

During most of Pennsylvanian time, the Illinois Basin gradually subsided; a maximum of about 3000 feet of Pennsylvanian sediments are preserved in the basin. The locations of the delta systems and the shoreline of the resulting coastal plain shifted, probably because of worldwide sea level changes, coupled with variation in the amounts of sediments provided by the river system and local changes in basin subsidence rates. These frequent shifts in the coastline position caused the depositional conditions at any one locality in the basin to alternate frequently between marine and nonmarine, producing a variety of lithologies in the Pennsylvanian rocks (see lithology distribution chart).

Conditions at various places on the shallow sea floor favored the deposition of sand, lime mud, or mud. Sand was deposited near the mouths of distributary channels, where it was reworked by waves and spread out as thin sheets near the shore. Mud was deposited in quiet-water areas — in delta bays between distributaries, in lagoons behind barrier bars, and in deeper water beyond the nearshore zone of sand deposition. Limestone was formed from the accumulation of limy parts of plants and animals laid down in areas where only minor amounts of sand and mud were being deposited. The areas of sand, mud, and limy mud deposition continually changed as the position of the shoreline changed and as the delta distributaries extended seaward or shifted their positions laterally along the shore.

Nonmarine sand, mud, and lime mud were deposited on the coastal plain bordering the sea. The nonmarine sand was deposited in delta distributary channels, in river channels, and on the broad floodplains of the rivers. Some sand bodies 100 or more feet thick were deposited in channels that cut through the underlying rock units. Mud was deposited mainly on floodplains. Some mud and freshwater lime mud were deposited locally in fresh-water lakes and swamps.

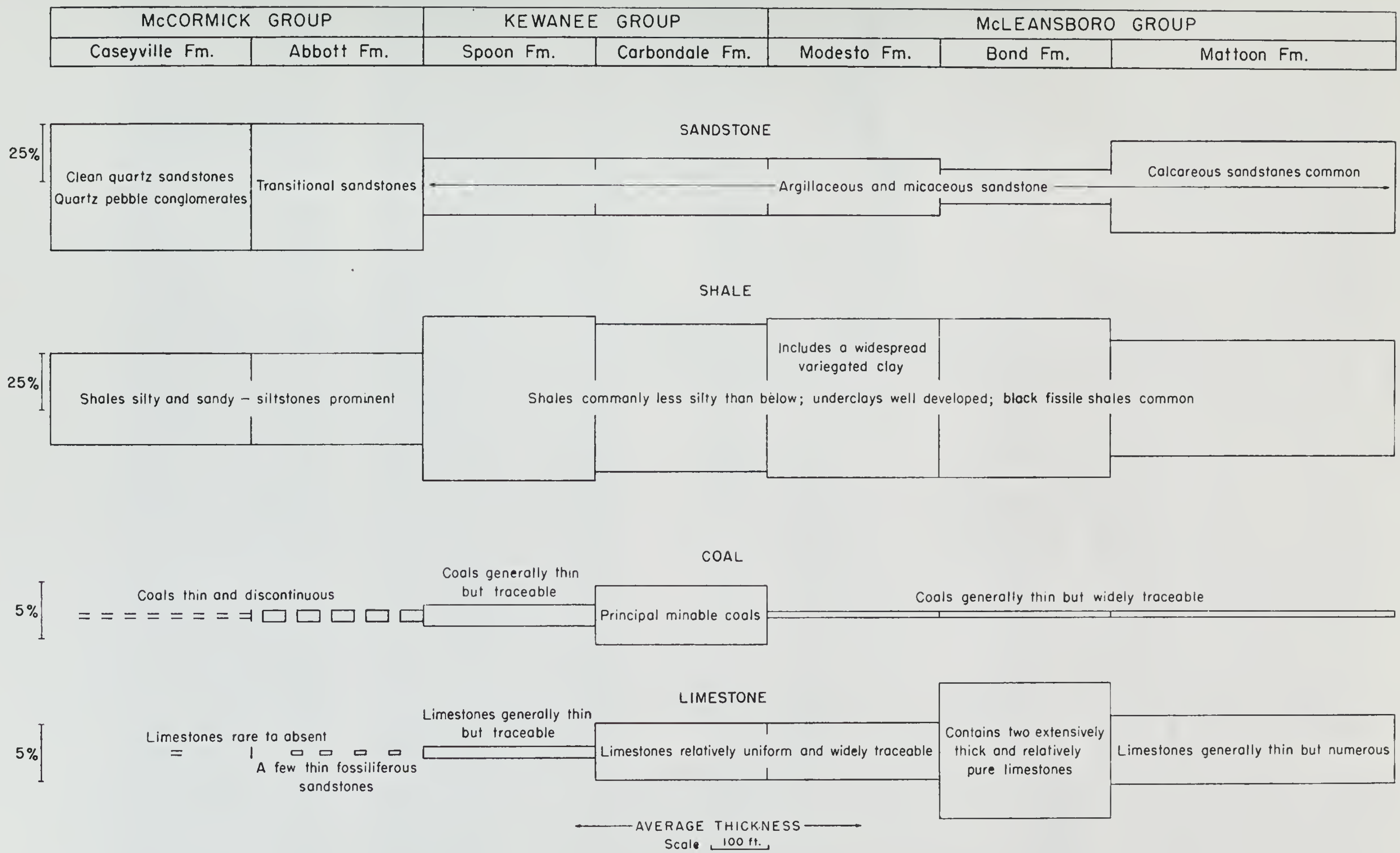
Beneath the quiet water of extensive swamps that prevailed for long intervals on the emergent coastal lowland, peat was formed by accumulation of plant material. Lush forest vegetation covered the region; it thrived in the warm, moist Pennsylvanian-age climate. Although the origin of the underclays beneath the coal is not precisely known, most evidence indicates that they were deposited in the swamps as slackwater mud before the accumulation of much plant debris. The clay underwent modification to become the soil upon which the lush vegetation grew in the swamps. Underclay frequently contains plant roots and rootlets that appear to be in their original places. The vast swamps were the culmination of nonmarine deposition. Resubmergence of the borderlands by the sea interrupted nonmarine deposition, and marine sediments were laid down over the peat.



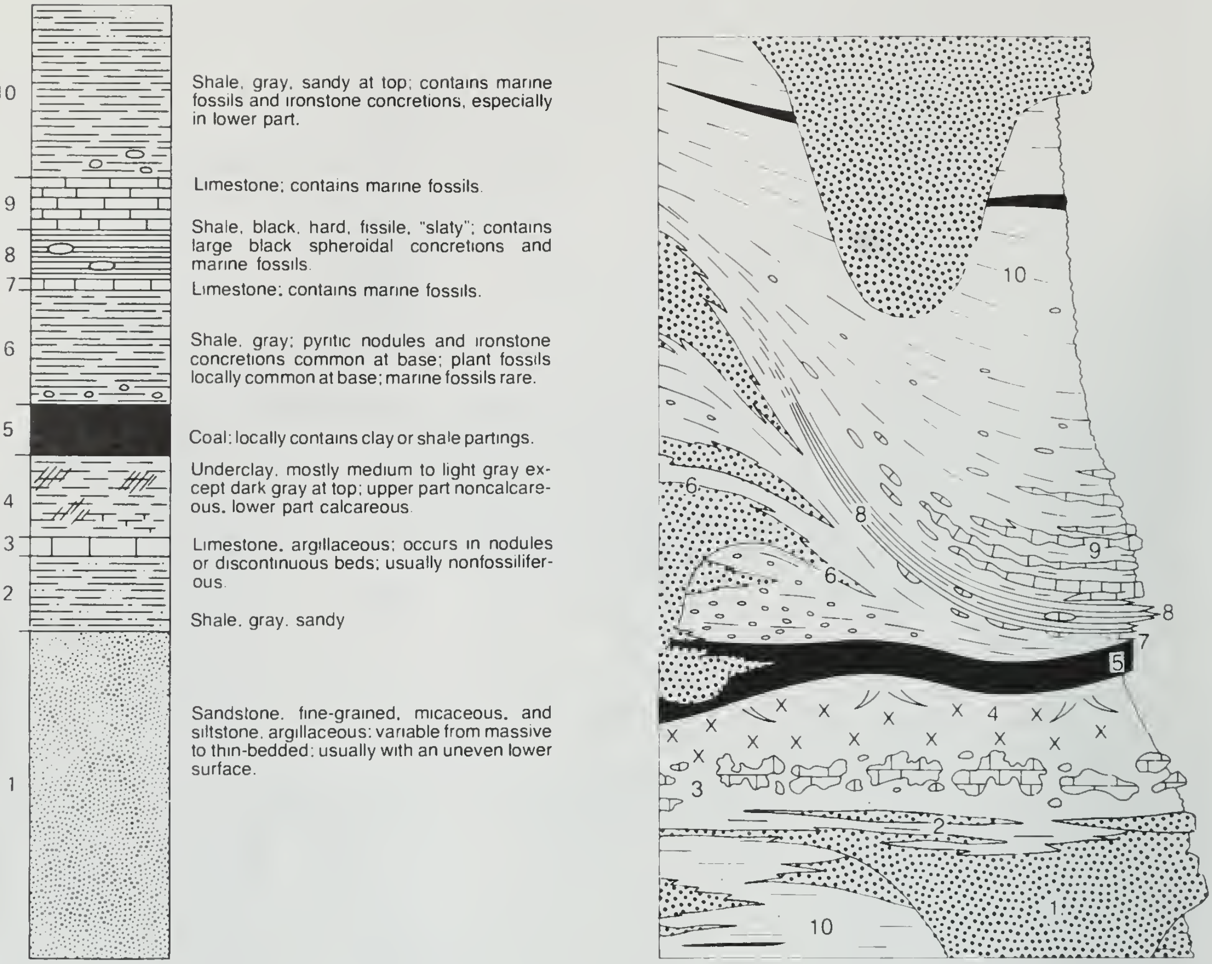
Paleogeography of Illinois-Indiana region during Pennsylvanian time. The diagram shows a Pennsylvanian river delta and the position of the shoreline and the sea at an instant of time during the Pennsylvanian Period.

Pennsylvanian Cyclothems

The Pennsylvanian strata exhibit extraordinary variations in thickness and composition both laterally and vertically because of the extremely varied environmental conditions under which they formed. Individual sedimentary units are often only a few inches thick and rarely exceed 30 feet thick. Sandstones and shales commonly grade laterally into each other, and shales sometimes interfinger and grade into limestones and coals. The underclays, coals, black shales, and some limestones, however, display remarkable lateral continuity for such thin units. Coal seams have been traced in mines, outcrops, and subsurface drill records over areas comprising several states.



General distribution of the four principal lithologies in Pennsylvanian strata of Illinois.



The idealized cyclothem at left (after Willman and Payne, 1942) infers continuous, widespread distribution of individual cyclothem units, at right the model of a typical cyclothem (after Baird and Shabica, 1980) shows the discontinuous nature of many units in a cyclothem.

The rapid and frequent changes in depositional environments during Pennsylvanian time produced regular or cyclical alternations of sandstone, shale, limestone, and coal in response to the shifting shoreline. Each series of alternations, called a cyclothem, consists of several marine and nonmarine rock units that record a complete cycle of marine invasion and retreat. Geologists have determined, after extensive studies of the Pennsylvanian strata in the Midwest, that an "ideally" complete cyclothem consists of ten sedimentary units (see illustration above contrasting the model of an "ideal" cyclothem with a model showing the dynamic relationships between the various members of a typical cyclothem).

Approximately 50 cyclothems have been described in the Illinois Basin but only a few contain all ten units at any given location. Usually one or more are missing because conditions of deposition were more varied than indicated by the "ideal" cyclothem. However, the order of units in each cyclothem is almost always the same: a typical cyclothem includes a basal sandstone overlain by an underclay, coal, black sheety shale, marine limestone, and gray marine shale. In general, the sandstone-underclay-coal-gray shale portion (the lower six units) of each cyclothem is nonmarine: it was deposited as part of the coastal lowlands from which the sea had withdrawn. However, some of the sandstones are entirely or partly marine. The units above the coal and gray shale are marine sediments deposited when the sea advanced over the coastal plain.

Origin of Coal

It is generally accepted that the Pennsylvanian coals originated by the accumulation of vegetable matter, usually in place, beneath the waters of extensive, shallow, fresh-to-brackish swamps. They represent the last-formed deposits of the nonmarine portions of the cyclothems. The swamps occupied vast areas of the coastal lowland, which bordered the shallow Pennsylvanian sea. A luxuriant growth of forest plants, many quite different from the plants of today, flourished in the warm, humid Pennsylvanian climate. (Illinois at that time was near the equator.) The deciduous trees and flowering plants that are common today had not yet evolved. Instead, the jungle-like forests were dominated by giant ancestors of present-day club mosses, horsetails, ferns, conifers, and cycads. The undergrowth also was well developed, consisting of many ferns, fernlike plants, and small club mosses. Most of the plant fossils found in the coals and associated sedimentary rocks show no annual growth rings, suggesting rapid growth rates and lack of seasonal variations in the climate (tropical). Many of the Pennsylvanian plants, such as the seed ferns, eventually became extinct.

Plant debris from the rapidly growing swamp forests — leaves, twigs, branches, and logs — accumulated as thick mats of peat on the floors of the swamps. Normally, vegetable matter rapidly decays by oxidation, forming water, nitrogen, and carbon dioxide. However, the cover of swamp water, which was probably stagnant and low in oxygen, prevented oxidation, and any decay of the peat deposits was due primarily to bacterial action.

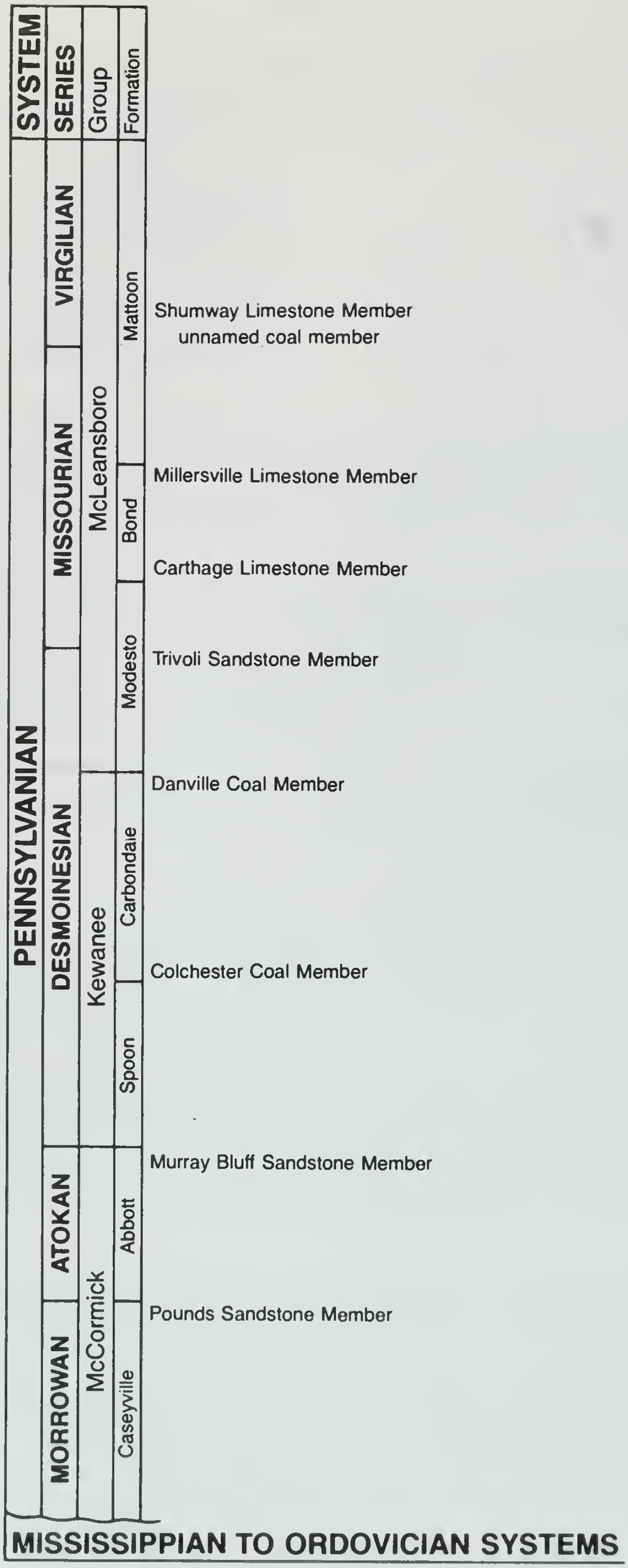
The periodic invasions of the Pennsylvanian sea across the coastal swamps killed the Pennsylvanian forests, and the peat deposits were often buried by marine sediments. After the marine transgressions, peat usually became saturated with sea water containing sulfates and other dissolved minerals. Even the marine sediments being deposited on the top of the drowned peat contained various minerals in solution, including sulfur, which further infiltrated the peat. As a result, the peat developed into a coal that is high in sulfur. However, in a number of areas, nonmarine muds, silts, and sands from the river system on the coastal plain covered the peat where flooding broke through levees or the river changed its coarse. Where these sediments (unit 6 of the cyclothem) are more than 20 feet thick, we find that the coal is low in sulfur, whereas coal found directly beneath marine rocks is high in sulfur. Although the seas did cover the areas where these nonmarine, fluvial sediments covered the peat, the peat was protected from sulfur infiltration by the shielding effect of these thick fluvial sediments.

Following burial, the peat deposits were gradually transformed into coal by slow physical and chemical changes in which pressure (compaction by the enormous weight of overlying sedimentary layers), heat (also due to deep burial), and time were the most important factors. Water and volatile substances (nitrogen, hydrogen, and oxygen) were slowly driven off during the coal-forming ("coalification") process, and the peat deposits were changed into coal.

Coals have been classified by ranks that are based on the degree of coalification. The commonly recognized coals, in order of increasing rank, are (1) brown coal or lignite, (2) sub-bituminous, (3) bituminous, (4) semibituminous, (5) semianthracite, and (6) anthracite. Each increase in rank is characterized by larger amounts of fixed carbon and smaller amounts of oxygen and other volatiles. Hardness of coal also increases with increasing rank. All Illinois coals are classified as bituminous.

Underclays occur beneath most of the coals in Illinois. Because underclays are generally unstratified (unlayered), are leached to a bleached appearance, and generally contain plant roots, many geologists consider that they represent the ancient soils on which the coal-forming plants grew.

The exact origin of the carbonaceous black shale that occurs above many coals is uncertain. Current thinking suggests that the black shale actually represents the deepest part of the marine transgression. Maximum transgression of the sea, coupled with upwelling of ocean water and accumulation of mud and animal remains on an anaerobic ocean floor, led to the deposition of black organic mud over vast areas stretching from Texas to Illinois. Deposition occurred in quiet-water areas where the very fine-grained iron-rich



Generalized stratigraphic column of the Pennsylvanian in Illinois (1 inch = approximately 250 feet).

mud and finely divided plant debris were washed in from the land. Most of the fossils found in black shale represent planktonic (floating) and nektonic (swimming) forms — not benthonic (bottom-dwelling) forms. The depauperate (dwarf) fossil forms sometimes found in black shale formerly were thought to have been forms that were stunted by toxic conditions in the sulfide-rich, oxygen-deficient water of the lagoons. However, study has shown that the "depauperate" fauna consists mostly of normal-size individuals of species that never grew any larger.

References

Baird, G. C., and C. W. Shabica, 1980, The Mazon Creek depositional event; examination of Francis Creek and analogous facies in the Midcontinent region: *in* Middle and late Pennsylvanian strata on margin of Illinois Basin, Vermilion County, Illinois, Vermilion and Parke counties, Indiana (R. L. Langenheim, editor). Annual Field Conference — Society of Economic Paleontologists and Mineralogists. Great Lakes Section, No. 10, p. 79-92.

Heckel, P. H., 1977, Origin of phosphatic black shale facies in Pennsylvanian cyclothems of mid-continent North America: American Association of Petroleum Geologist Bulletin, v. 61, p. 1045-1068.

Kosanke, R. M., J. A. Simon, H. R. Wanless, and H. B. Willman, 1960, Classification of the Pennsylvanian strata of Illinois: Illinois State Geological Survey Report of Investigation 214, 84 p.

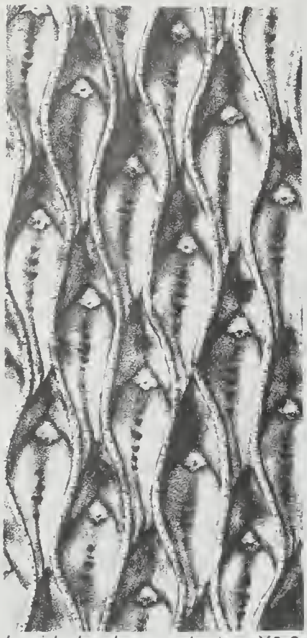
Simon, J. A., and M. E. Hopkins, 1973, Geology of Coal: Illinois State Geological Survey Reprint 1973-H, 28 p.

Willman, H. B., and J. N. Payne, 1942, Geology and mineral resources of the Marseilles, Ottawa, and Streator Quadrangles: Illinois State Geological Survey Bulletin 66, 388 p.

Willman, H. B., et al., 1967, Geologic Map of Illinois: Illinois State Geological Survey map; scale, 1:500,000 (about 8 miles per inch).

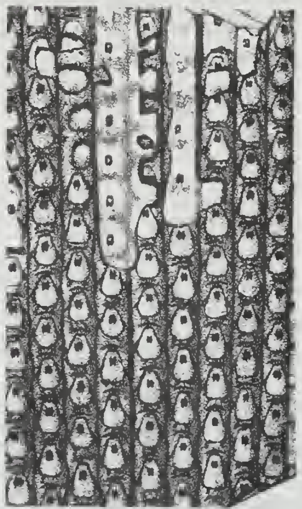
Willman, H. B., E. Atherton, T. C. Buschbach, C. W. Collinson, J. C. Frye, M. E. Hopkins, J. A. Lineback, and J. A. Simon, 1975, Handbook of Illinois Stratigraphy: Illinois State Geological Survey Bulletin 95, 261 p.

Common Pennsylvanian plants: lycopods, sphenophytes, and ferns



Lepidodendron aculeatum X0.8

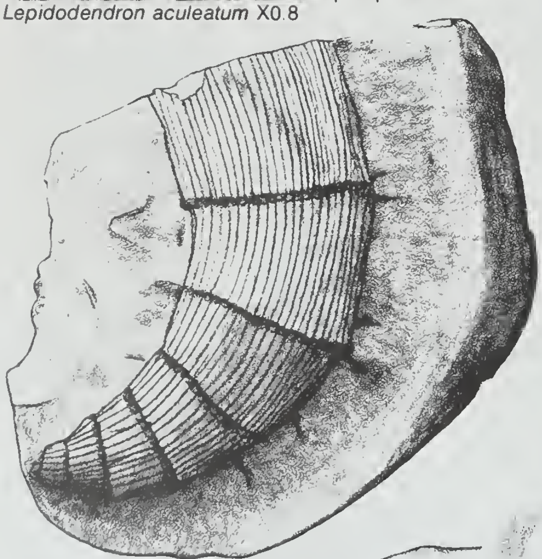
Lepidophloios laricinus X0.63



Sigillaria mammilaris X0.5

Stigmaria ficoides X0.32

Lepidostrobus ovatifolius X0.8



Calamites suckowii X0.5

Annularia stellata X0.63

Sphenophyllum cuneifolium X0.4

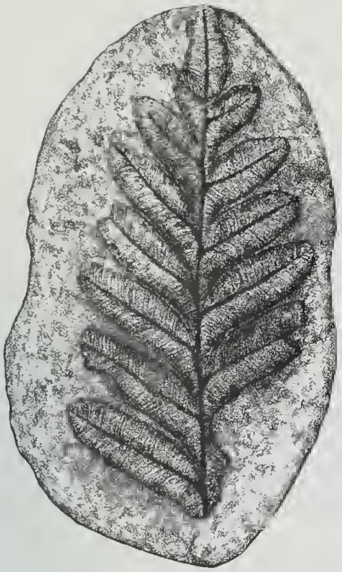
Pecopteris sp. X0.32

Pecopteris miltonii X2.0

Pecopteris hemitelioides X1.0

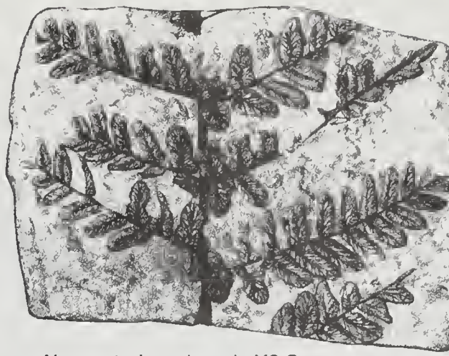
J. R. Jennings, ISGS

Common Pennsylvanian plants: seed ferns and cordaiteans



Alethopteris serlii X0.63

Alethopteris ambigua X0.63

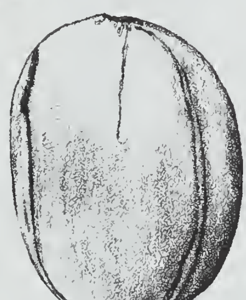


Neuropteris rarinervis X0.5

Mariopteris nervosa X0.8

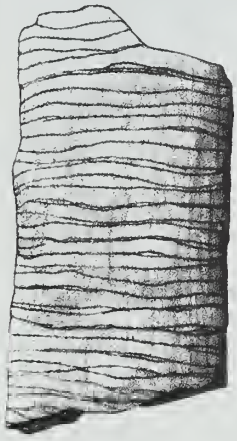
Neuropteris scheuchzeri X0.63

Sphenopteris rotundiloba X0.8



Trigonocarpus parkinsonii X1.25

Cordaicladus sp. X1.0

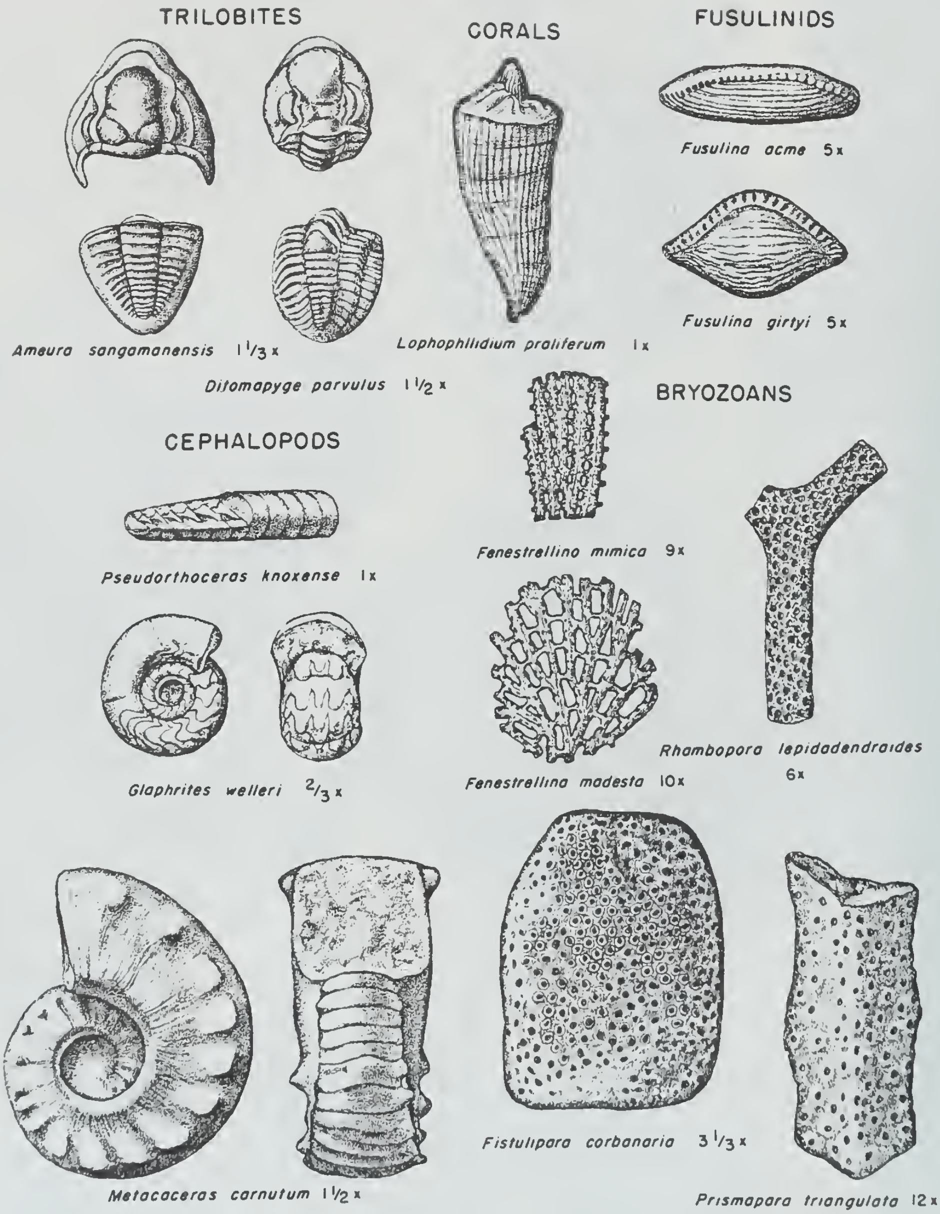


Artisia transversa X0.63

Cordaicarpon major X2.0

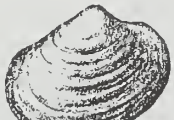
Cordaites principalis X0.63

J. R. Jennings, ISGS


TRILOBITES
CORALS
FUSULINIDS
Fusulina acme 5x
Fusulina girtyi 5x
Ameura sangamanensis 1 1/3 x
Lophophyllidium proliferum 1 x
Ditomopyge parvulus 1 1/2 x
BRYOZOANS
CEPHALOPODS
Pseudorthoceras knoxense 1 x
Fenestrellina mimica 9x
Rhombopora lepidodendroides
6x
Glaphrites welleri 2/3 x
Fenestrellina modesta 10x
Fistulipora carbonaria 3 1/3 x
Metacoceras cornutum 1 1/2 x
Prismopora triangulata 12 x

PELECYPODS

Nucula (Nuculopsis) girtyi 1x



Edmonia ovata 2x

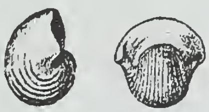
Astartella concentrica 1x

Dunbarella knighti 1½x

Cardiomorpha missouriensis "Type A" 1x

Cardiomorpha missouriensis "Type B" 1½x

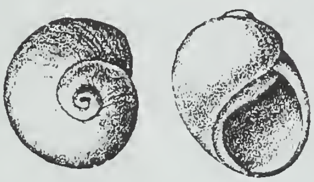
GASTROPODS



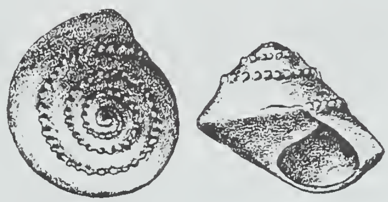
Euphemites carbonarius 1½x

Donaldina robusta 8x

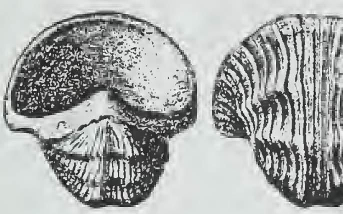
Trepospira illinoisensis 1½x



Naticopsis (Jedria) ventricosa 1½x



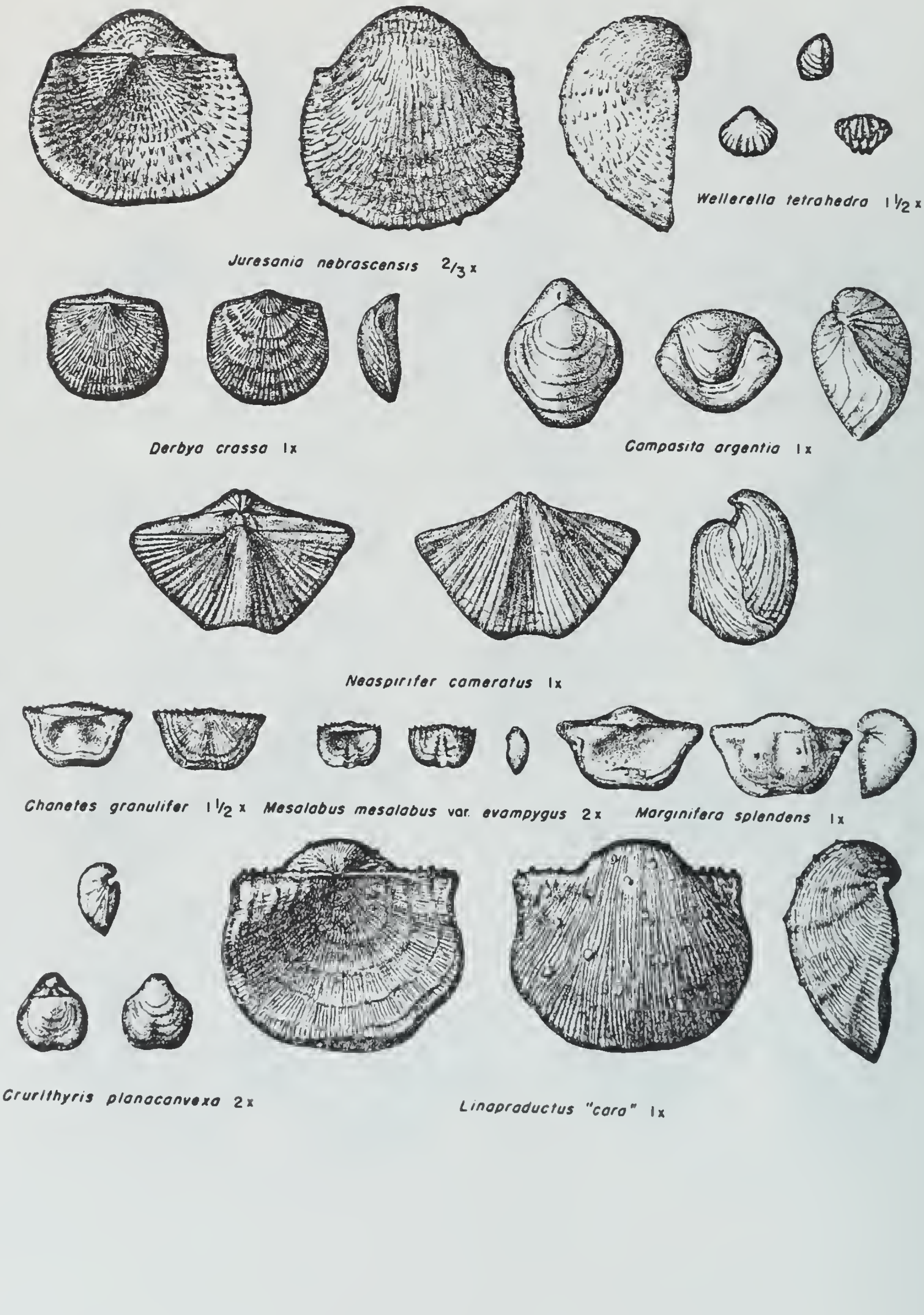
Trepospira sphaerulata 1x



Knightites montfortianus 2x

Glabrocingulum (Glabrocingulum) grayvillense 3x

BRACHIOPODS



Juresania nebrascensis 2/3 x

Wellerella tetrahedra 1 1/2 x

Derbya crassa 1x

Composita argentia 1x

Neospirifer cameratus 1x

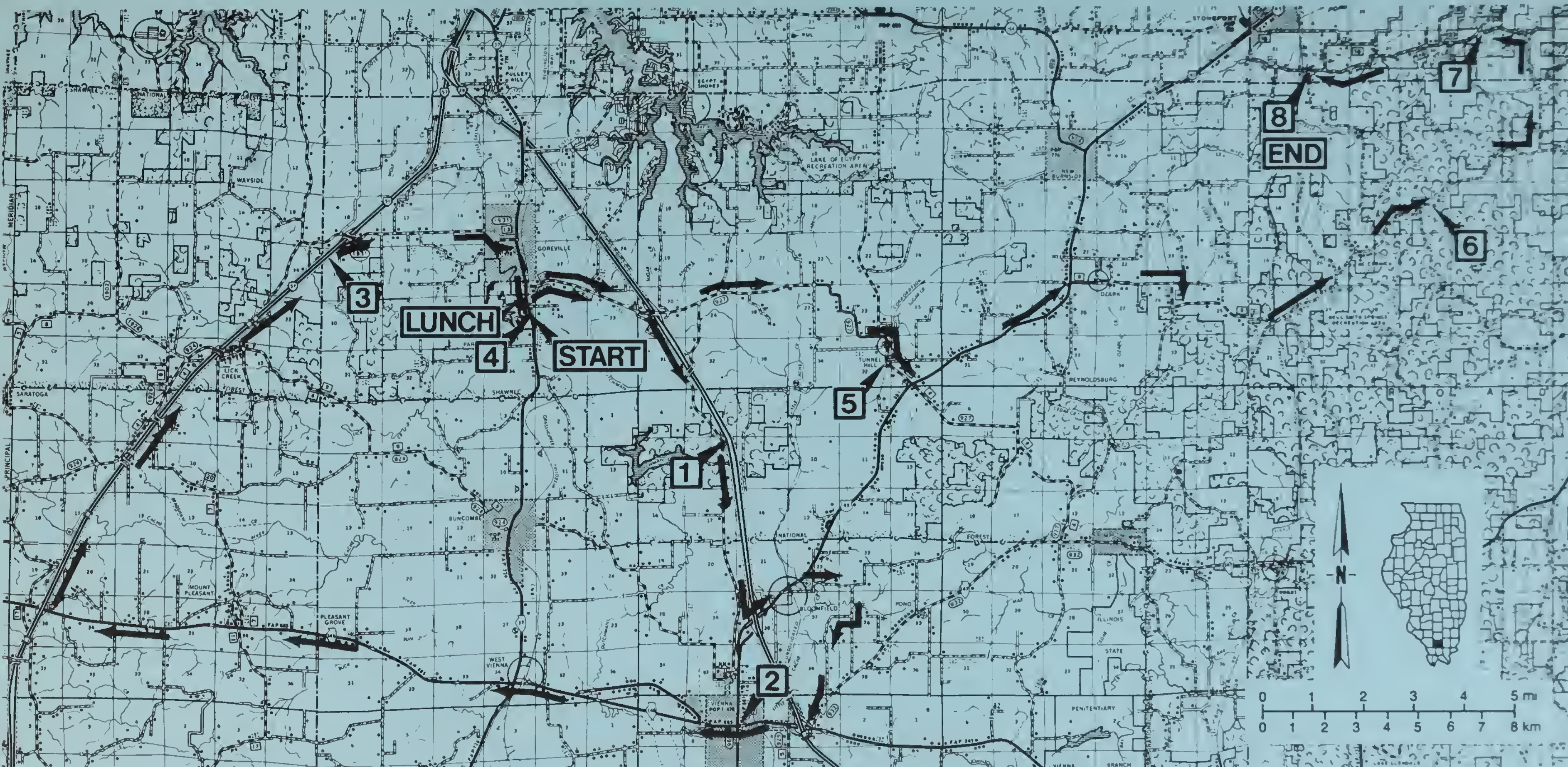
Chonetes granulifer 1 1/2 x

Mesolobus mesolobus var. euampygus 2x

Marginifera splendens 1x

Crurithyris planoconvexa 2x

Linoproductus "cora" 1x



START
LUNCH
1
2
3
4
5
6
7
8
END
N
0 1 2 3 4 5 mi
0 1 2 3 4 5 6 7 8 km
GOREVILLE
LAKE OF EGYPT RECREATION AREA
TUNNEL HILL
REYNOLDSBURG
OZARK
BUNCOMBE
BLOOMFIELD
VIENNA
WEST VIENNA
PLEASANT GROVE
MOUNT PLEASANT
LICK CREEK
WAYSIDE
SARATOGA
SHAWNEE
NATIONAL
FOREST
ILLINOIS
STATE
PENITENTIARY
VIENNA
BRANCH
PRINCIPAL
MERIDIAN